THE ENGINEER

A Seven-Day Journal

Road Transport of Abnormal Loads

THE Minister of Transport has made a new order dealing with the movement on roads of motor vehicles and trailers specially constructed to carry abnormal indivisible loads and with the movement of motor vehicles and trailers which are defined as "engineering plant." The Order, which will come into force on January 1, 1952, is entitled the Motor Vehicles (Authorisation of Special Types) Order, 1951, and it replaces part of an Order on the same subject which was made in 1941. It does not allow movements of abnormal indivisible loads which exceed 150 tons gross or 20ft overall width. The effect of this is that a special Order will require to be made authorising each movement of a load of such dimensions, and, before making such an Order, the Minister of Transport will need to be satisfied that the movement is unavoidable and is practicable having regard to the possible routes. The Ministry therefore advises manufacturers of heavy plant to consult it, as to the prospects of an Order being issued, before contracting to manufacture any piece of equipment likely with its carrier to exceed 150 tons which has to be moved by road after next December. Another provision of the Order now made is that where the total laden weight of a vehicle or combination of vehicles exceeds 75 tons, six days' notice, instead of two days', must be given to the highway and bridge authorities concerned, and two days' notice must be given to the police. The speed limit of 5 m.p.h. is to be extended to 12 m.p.h. for certain loads, and special motor vehicles for the carriage or hauling of abnormal indivisible loads may have an overall width not exceeding 9ft 6in, instead of 9ft, an extension which applies also to trailers. Notice to the police of intended movements will be necessary only if the width of vehicle and load exceeds 9ft 6in, where the route is not alongside tram tracks. "Engineering plant" is defined in the new Order to include certain vehicles—dumpers, for example—not constructed primarily to carry a load.

Conference on Heat Transfer

As recorded in our last issue, the general discussion on "Heat Transfer," arranged by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers, was held in London on Tuesday, Wednesday and Thursday, September 11th, 12th and 13th. At the opening session, Mr. A. C. Hartley, President of the Institution of Mechanical Engineers, was in the chair, and, after welcoming overseas visitors, said that the response in the way of papers and attendance at the conference indicated the keenness with which a discussion on heat transfer problems had been awaited. It was impressive to note, Mr. Hartley continued, that forty institutions in Europe and eleven in North America were co-operating in the work of the conference. Moreover, the assistance of the Conference of Engineering Institutions of the British Commonwealth and the Conference of Representatives from the Engineering Societies of Western Europe and the U.S.A., was particularly welcome. Professor A. P. Colburn, Ph.D., spoke on behalf of the American Society of Mechanical Engineers, and Professor O. A. Saunders, chairman of one of the two organising committees, explained that at each session two reporters, dealing with the European and North American contributions respectively, would present summaries of the papers. The two sessions on the first day were devoted to the discussion of papers on "Heat Transfer with Change of State" and "Heat Transfer between Fluids and Surfaces." On Wednesday, the papers presented dealt with "Conduction in Solids and Fluids" and "Radiation, Instrumentation, Measurement Techniques and Analogies," and on the final day the papers discussed covered "Special Problems." As part of the conference programme, Professor A. P. Colburn, Head of the Chemical Engineering Division at the University of Delaware delivered a James Clayton Lecture on Wednesday evening on "Problems in Design and Research on Condensers of Vapours and Vapour Mixtures." The lecture dealt with various aspects of research now in progress at the University of Delaware, especially that directed to finding answers to unsolved problems in heat transfer. A reception and conversazione at the Institution of Mechanical Engineers was held on Tuesday evening of last week, and the proceedings were concluded on Thursday by a dinner at St. Ermin's Hotel.

Blast Furnace Capacity

IN the latest issue of its *Monthly Statistical Bulletin*, which has appeared this week, the British Iron and Steel Federation has discussed this country's steel supply prospects. In the course of its survey, the Federation says that considerable increases in blast-furnace capacity are due to come in during the next few months, and still more next year. As well as new or rebuilt blast-furnaces, there will be additional ore-treatment and sintering plants, and improved ore unloading and handling facilities. It is estimated that these developments will add approximately 500,000 tons to the industry's annual iron-making capacity by the end of the present year. It is also estimated that capacity will be available for the production of 11,000,000 tons of pig iron and ferro-alloys in 1952. But, the Federation emphasises, the paramount need is to secure adequate supplies of coke and ore to keep all the blast-furnaces working to capacity. Its survey shows that capacity production of pig iron would make possible a steel output of 16,000,000 tons this year and 16,500,000 tons next year, provided, of course, that the expected supplies of scrap were also forthcoming. The Federation adds that prospects for raw materials in 1952 would be more promising if larger coal supplies were in view. Indeed, it is observed, "the connection is so close that the coal shortage is causing serious concern in the steel industry."

Royal Aeronautical Society Awards

ON the occasion of the thirty-ninth Wilbur Wright Memorial Lecture, which was delivered in London on September 10th, the Gold Medal of the Royal Aeronautical Society, its highest award, was conferred posthumously upon Mr. W. G. A. Perring, in recognition of his distinguished service to aeronautical science. It will be recalled that from 1945 until his death on April 9, 1951, Mr. Perring was Director of the Royal Aircraft Establishment, Farnborough, and was Director Designate of the new National Aeronautical Establishment at Bedford. The Society's Silver Medal, awarded for outstanding work in aeronautics, was conferred upon S. B. Gates, for his work on the stability and control of aircraft, and H. J. Pollard received the Society's Bronze Medal for his many contributions to the development of aircraft construction. There were eight other medals and prizes awarded by the Council, two of which were conferred upon test pilots. The British Silver Medal, awarded for practical achievement leading to advancement in aeronautics, was given to Group Captain J. Cunningham, for his outstanding achievements as a test pilot, and the R. P. Alston Memorial Prize, which is associated with flight testing, was awarded to R. J. Falk, for his flight testing of delta wing aircraft. The British Gold Medal was awarded to A. E. Russell for practical achievement in aircraft design. Medals awarded annually at the discretion of the Council were presented to R. E. Bishop for his paper on "Design for Maintenance"; Dr. G. S. Hislop, for his paper on "Investigation of Gusts"; A. V. Cleaver, for his paper on "Rockets and Assisted Take-off"; R. Hills, for his paper on "The Use of Wind Tunnel Model Data," and to Dr. Neumark, for his paper on "Swept-back Wings."

A Constructional Steelwork Productivity Team

THE Anglo-American Council on Productivity announces that a team consisting of fourteen representatives of the British constructional steelwork, bridge building and mechanical handling interests is leaving to-day for a visit to the U.S.A. The team, which is led by Lieut.-Colonel H. B. Denton, chairman of Joseph Parks and Son, Ltd., Wolverhampton, is sponsored by the trade associations concerned, including the British Constructional Steelwork Association, the Mechanical Handling Engineers' Association, and the Engineering and Allied Employers' National Federation. Visits are being arranged to American firms fabricating structural steelwork, bridges and oil tanks, and to firms specialising in power line transmission towers and structural steelwork accessories. It is also intended that the team shall visit an ore storage and handling plant and the establishment of a steel stock holder.

International Road Congress at Lisbon

THE ninth International Road Congress will be held in Lisbon, starting on Monday next, September 24th. Sixty-four papers have been submitted by the various nations attending in answer to the six "questions" which will be discussed. The congress will continue for about a fortnight, including the time devoted to technical visits, which include a visit to Madeira. The six questions are, in general, related to the progress made in the study of each one since the last congress at The Hague in 1938. They are devoted to the following topics:—Question 1 is about the use of cement or special materials in the construction of road and runway surfacings, and in the preparation and the use of plastic binders on roads and runways; question 2 concerns the study of road subgrades, methods of testing and measurement and the stabilisation of soils; question 3 discusses road design and studies of traffic under the headings of the speed of the vehicles, type of traffic, overtaking and design of intersections; the economic justification of roads is the subject of question 4; question 5 is devoted to the construction and maintenance of roads in general, and urban roads in particular; lastly, in question 6, the construction and maintenance of roads in thinly populated or under-developed countries are discussed. At the time of going to press, summaries or copies of the papers have not been published, but a symposium of papers on plant, entitled "British Manufactured Mechanical Equipment for Road Construction and Maintenance," which will be submitted in addition to the six questions, has been published. The symposium includes descriptions of excavating plant, and plant used for bridge construction, so that altogether a fairly comprehensive account of contractors' plant manufactured in this country is given. Copies of the symposium may be obtained from Mr. P. Otway, 14, Howick Place, London, S.W.1, at a price of 6s.

The Grand Coulee Pumping Plant, Coulee Dam, Washington

No. I

THE first 65,000 h.p. pump at the Grand Coulee pumping plant at Coulee Dam, in the State of Washington, was placed in regular operation on June 14, 1951. Contracts have already been issued for the construction and erection of an additional five pumps, which are expected to be installed by the autumn of 1952. Eventually the pumping plant will comprise a total of twelve pumps with a combined maximum capacity of almost 20,000 cusecs. These pumps are of unprecedented size and require nearly five times the amount of power used by the next largest pumping unit in operation in the United States. The Grand Coulee pumping plant is a part of the Columbia Basin Project and in order to establish the significance of the plant, it is proposed here to review briefly the history and the scope of the project, the extent of which is shown on the map in Fig. 2.

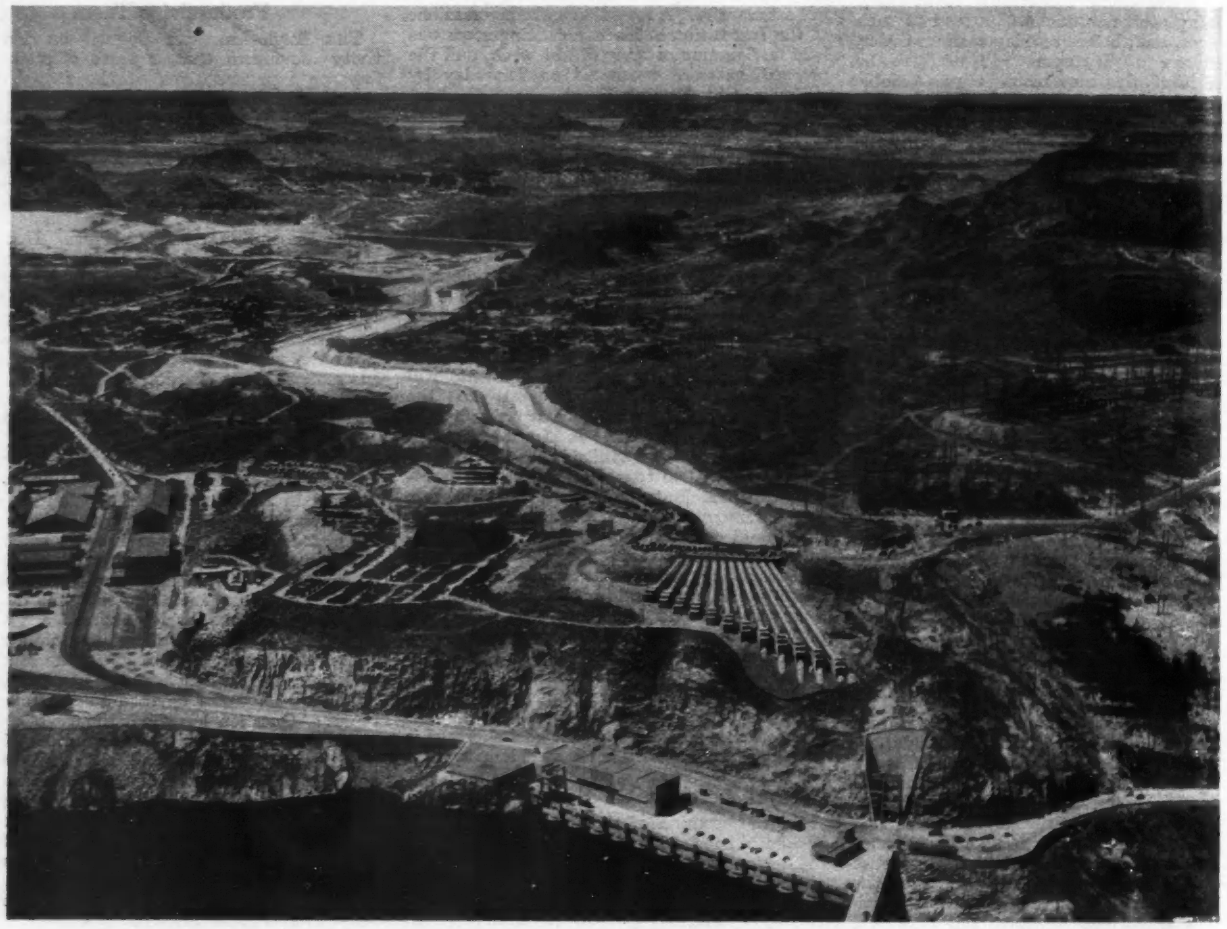


FIG. 1—AERIAL VIEW OF PUMPING PLANT

THE COLUMBIA BASIN PROJECT

Pioneers began to settle in the Columbia Basin area of eastern Washington toward the end of the nineteenth century. Following a succession of dry years, which drove many of them from the region, those who remained turned their attention to irrigating the "dry Columbia Plains" with water from deep artesian wells. In 1904, the U.S. Reclamation Service investigated the possibilities of irrigating an area along the Columbia River in the Grant, Adams and Franklin Counties of eastern Washington, by means of canals, using the Columbia, Spokane and Palouse Rivers for water supply. In 1918 suggestions were made that a dam be built on the Columbia River high enough to divert water into the Grand Coulee, an ice-age river-bed of the Columbia, which would carry the flow by gravity for more than fifty miles to the northern end of the irrigable area at Soap Lake. The Washington State Legislature subsequently created the Columbia Basin Survey Commission to study irrigation possibilities of the Basin area. The report of the Commission, published in 1920, discussed a dam and pumping plant in the Columbia River Canyon at the head of the Grand Coulee, but concluded that the dam would be impracticable—perhaps impossible. It favoured an all-gravity plan, which would take irrigation water from the Pend Oreille River at Albeni Falls in northern Idaho. Local backers of the dam, however, sought further professional opinions regarding the merits of the two plans. At their request, A. P. Davis, the director at the time of the U.S. Reclamation Service, and Hugh Cooper, a well-known builder of dams, visited the Grand Coulee dam site and recommended, after careful consideration, that further studies of the project were warranted. Core drilling at the Grand Coulee dam site was recommended by a Reclamation Service review board, which found the State Commission's cost estimates too low for the gravity plan and too high for the pumping plan. This investigation disclosed excellent granite bedrock at reasonable depth. Late in 1921 Willis T. Batcheller, an engineer employed by the State of Washington, reinvestigated the Grand Coulee dam and pumping plant plan and recommended it over the Pend Oreille gravity irrigation plan. A comprehensive report prepared by the U.S. Corps of Engineers in 1932 concluded that the development of the Columbia River for water power, irrigation and flood control would best be served by the construction of the Grand Coulee dam and several other downstream dams. That report considered a total of seven plans for supplying irrigation water to Columbia Basin lands, five by gravity and two by pumping. The Bureau of Reclamation then reviewed all the Columbia Basin investigations and issued a report recommending the development of the Columbia Basin project, substantially as it exists to-day. The President of the United States approved the Bureau's comprehensive review report in 1933 and allotted funds for the construction of Grand Coulee dam. The first construction contract was awarded on July 16, 1934.

The accompanying map shows that in its generally south-westerly course from Canada to the Pacific Ocean, the Columbia River in central Washington forms a half-loop between the mouths of the Spokane and Snake Rivers, known generally as the Big Bend. During a prior ice age, a glacier extended across the present river channel, diverting the flow generally across the open eastern side of the Big Bend loop. By the time the ice age had passed this diverted water had eroded the Grand Coulee so that when the ice barrier receded, the river returned to its present channel, leaving the Coulee as a potential high elevation reservoir—requiring only to be sealed at each end and filled with water. The Columbia Basin project includes the following installations,

FIG. 2—COLUMBIA BASIN PROJECT

which function together as a unit: the Grand Coulee dam and power plant, forming the Franklin D. Roosevelt Lake, a storage reservoir on the Columbia River; the Grand Coulee pumping plant, at the dam, to pump water from Roosevelt Lake into the Grand Coulee equalising reservoir through a feeder canal; the North and South Coulee dams, at either end of Grand Coulee, creating the equalising reservoir; and the main canal, leading from the South dam in a southerly direction, including the Bacon tunnel and siphon and connecting Trail and Long Lakes. From Long Lake the main canal extends westerly to its terminus, about 5 miles west of Stratford; the East high canal, flows generally south-easterly from the main canal to part of the project lands; the Long Lake, raised by a dam, functions as a segment of the main canal; the East low canal, flows southerly from the terminus of the main canal to serve lands west of those served by the East high canal; the West canal, flows generally south-westerly from the terminus of the main canal to serve part of the project lands; the Quincy lateral, extends west from the West canal to serve lands to the south-west of Ephrata; the O'Sullivan dam and Potholes reservoir, extends Moses Lake and receives surplus flows from the West and East low canals through the Winchester and Rocky Coulee wasteways, respectively; the Potholes West canal and Potholes East canal, flows south-westerly and south-easterly from the Potholes reservoir to serve part of the project lands; the Wahluke Slope lateral, takes water from the Potholes East canal to lands to the south of Smyrna; the Pasco pumping plant, on the Columbia River, above the mouth of the Snake River, serves lands at the southern end of the project; the Burbank pumping plant and canal, on the Snake River, above its confluence with the Columbia, serves lands near the junction of the two streams.

The Columbia Basin project is a multiple-purpose reclamation development with a project area approximately 80 miles long and 60 miles wide. Of a total project area of 2,500,000 acres, 1,029,000 acres have been found suitable for irrigation. The large-scale settlement of the project is now drawing near. In 1952 the Bureau of Reclamation plans to have sufficient canals, siphons, dams and other structures in readiness to carry water to the first 87,000 acres in the Basin. In succeeding years additional irrigation blocks will be served with water until, in 1959, there is expected to be a stable supply available for approximately 500,000 acres, or half the irrigable acreage. To-day, the Basin is a sparsely settled area. Most of it still is as it has been for years: great expanses of sagebrush-covered land extending as far as the eye can see. Because of the extreme dryness of the area, there is little farming development. But the land is fertile and can grow a wide variety of crops if given irrigation water. Only a few thousand persons now live in the area to be irrigated. Some 13,000 family-size irrigated farms ultimately will be established in the Basin and the population is expected to reach approximately 200,000.

Grand Coulee Dam

The principal engineering feature of the Columbia Basin project is Grand Coulee dam, the largest concrete structure on earth. In connection with the irrigation development the Grand Coulee dam will:

(1) Facilitate payment of more than three-quarters of the total estimated cost of the entire development by the sale of power generated at the dam. The project is estimated to cost a total of 715,100,000 dollars, including the cost of the irrigation structures, the Grand Coulee dam and related facilities.

(2) Furnish power for driving the large irrigation pumps, now being installed at the Grand Coulee dam pumping plant.

(3) Furnish low-cost power for secondary pumping throughout the project area so that water from the canals will be able to reach higher-level farm lands.

(4) Make low-cost power available for widespread use on the irrigated farms to be established in the basin; and

(5) Raise the level of the Columbia River by creating the Franklin D. Roosevelt Lake, thus facilitating the pumping of the primary water supply for the project.

It will be recalled that the power plant at Grand Coulee dam consists of two power stations on the downstream side of the dam, the left one (on the west side) and the right one (on the east side). The west power station (Fig. 7) began producing electricity on March 22, 1941, when two 10MW "house" generators commenced operation. When the final three 108MW turbo-generators are completed this year the dam will have a total of eighteen major generating units in operation. Their total rated capacity will be 1944MW. In addition, there are 30MW being generated by three "house" units, thus bringing the total rated generating capacity to 1974MW. Under peak conditions, the plant will be able to carry loads approaching 2370MW. This peak capacity, however, can be realised only under optimum water conditions, which can prevail only if adequate upstream storage is provided by additional dams.

Six of the 108MW generators will be used on a part-time basis for irrigation pumping, so as to achieve the maximum development of the Columbia Basin project. For the first four years one or two units will be used for irrigation work. Off-peak power will be used to the greatest extent practicable. This is, in many cases, idle capacity. Such use is possible because the season of irrigation needs coincides with the season of minimum power demand in industrial and home centres of the Pacific North-West of

GRAND COULEE DAM AND PUMPING PLANT, WASHINGTON

FIG. 3—GRAND COULEE DAM

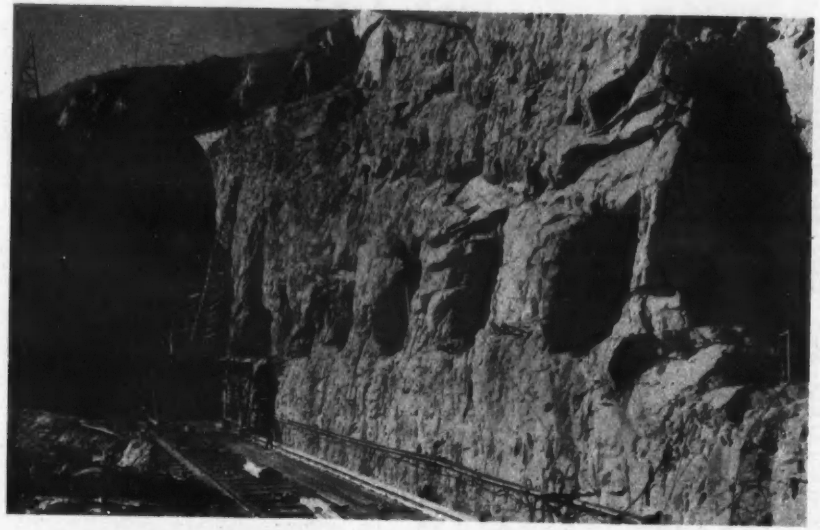


FIG. 4—PUMPING PLANT EXCAVATION AND DISCHARGE PIPE TUNNELS

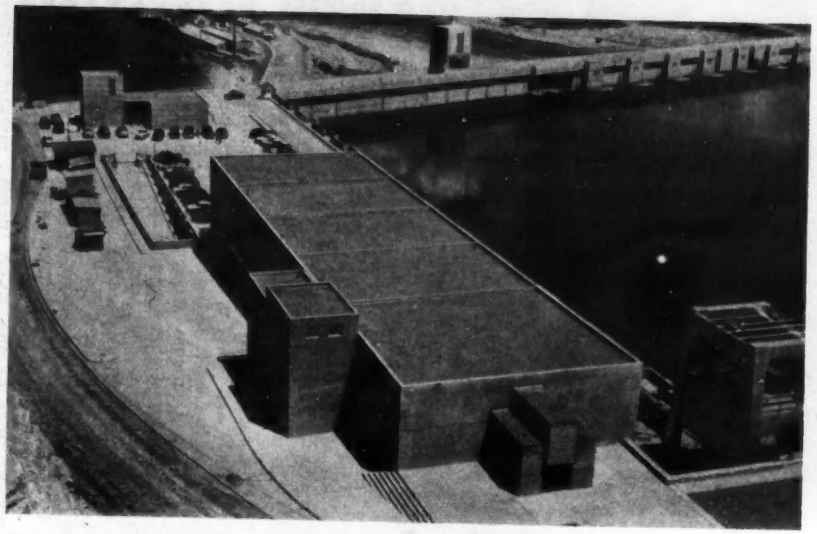


FIG. 5—COMPLETED PUMP HOUSE

FIG. 6—ERECTION OF PUMP CASING

the United States. A second factor, which makes possible the use of off-peak power, is the storage reservoir in the Grand Coulee, the ice age channel of the Columbia River. This reservoir can store 1,202,000 acre-feet of water, of which 700,000 is usable for irrigation purposes.

Since it began producing commercial power on March 22, 1941, the Grand Coulee dam has turned out a total of approximately 59,000,000,000kWh of electric energy. In the last war it made possible the establishment of the atomic energy installations at Hanford, the growth of Spokane as one of the aluminium capitals of the world, and the firm establishment of scores of new industries throughout the Pacific North-West. Aluminium plants in the Pacific North-West now consume 45 per cent of the power generated by the Grand Coulee and Bonneville dams, the two federal power dams in the Pacific North-West Power Pool. The Bonneville Power Administration system, which markets the electricity generated at Grand Coulee dam and at Bonneville dam, serves twelve electro-processing plants. The total revenues received from the sale to date of Columbia River power to these electro-processing plants exceeds 100,000,000 dollars.

Franklin D. Roosevelt Lake

Franklin D. Roosevelt Lake is the 151-mile-long reservoir formed by the Grand Coulee dam (Fig. 3). It occupies the valley cut by the Columbia River and extends from the Grand Coulee dam to the Canadian border. The lake does not extend into Canada. The primary purpose of the lake is to reduce the lift distance for irrigation water for the Columbia Basin project, and to provide a head for power production. The creation of the lake raised the waters of the Columbia approximately 350ft, to make irrigation pumping feasible. Incidentally, because the pumping season and the peak flow of the Columbia will occur simultaneously in the spring and summer, Lake Roosevelt will not be drawn down during that period of the year. Lake Roosevelt terminates in a 320ft water-fall at the Grand Coulee dam. The spillway is designed to discharge 1,000,000 cusecs and an additional 200,000 cusecs can be discharged through outlet tunnels through the dam.

The Pumping Plant

During 1938 and 1939, when the Grand Coulee dam was under construction, a cavity was blasted out of the granite cliff at the west end of the dam, Fig. 4, to become

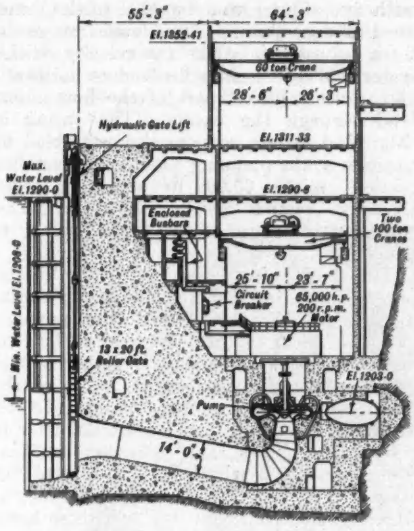


FIG. 8—SECTION THROUGH PUMP HOUSE

the site of the Grand Coulee pumping plant. Twelve tunnels, 17ft in diameter and 411 to 466ft in length, were bored up through the rock backwall to carry the steel discharge pipes to the headworks of a feeder canal on top of the hill. In July, 1940, the 664ft wing dam adjoining the west end of the main Grand Coulee dam was approaching its final height of 226ft above lowest bedrock. Inlet pipes, each 60ft long and 14ft diameter had been built into the wing dam for the twelve pumps. All plans to develop the irrigation phases of the Columbia Basin project were tabled after the United States entered the last war. In November, 1948, the Bureau of Reclamation awarded a contract for 13,982,593 dollars to the Morrison-Knudsen Company and the Peter Kiewit Sons' Company for the supply and installation of the pumping plant. The contract included the discharge pipes, the headworks for the feeder canal, the first section of the canal and related work and was completed in the spring of this year.

The pumping plant is approximately fifteen stories high but only the top two stories are visible from the road level at the top of Grand Coulee dam. Elevations in feet above sea level to different sections of the pump and motor are as follows :—

Ft.
1171—Bottom of pump pit.
1172—Bottom of water intake.
1194·33—Bottom of foundation ring.
1203—Centre-line of spiral casing.
1212—Top of pump.
1220—Top of pump shaft.
1220—Bottom of motor-shaft.
1226—Bottom of motor-housing.
1234—Top stator flange.
1240—Inspection balcony in pump plant.
1247—Top of motor.
1290—Surface of Franklin D. Roosevelt Lake.
1570—Top water level in feeder canal on top of the hill.

The pump-house, Fig. 5, includes an office wing, a storage warehouse and a tourist reception unit. A ramp leads to a parking platform underground. Three lifts will be installed to take tourists and workers to the inner levels of the plant. Travelling along the top of the wing dam there is a 75-ton gantry crane to lower or raise the reverse-flow roller gates, which control the water entry to the pumps. A 60-ton overhead crane handles heavy shipments of machinery as they arrive in the storage warehouse above the pumping plant deck. Sections of equipment are lowered by crane from the storage warehouse to the pump-room floor, approximately six stories below. There are two 100-ton overhead cranes to lift the heavier sections of motors and pumps as they are assembled inside the pump-room.

The Pumps

Contracts for the manufacture of the first six pumps were awarded in 1946 to the Pelton Water Wheel Company of San

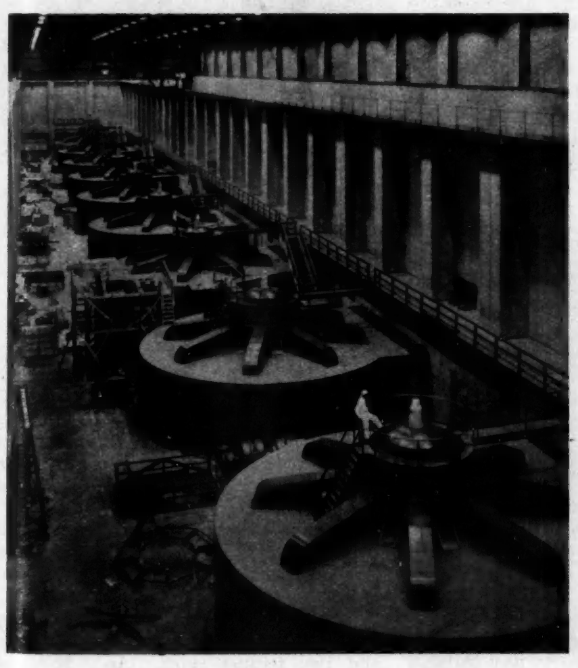


FIG. 7—WEST POWER STATION

FIG. 9—ASSEMBLY OF PUMP SHAFT AND IMPELLER

Francisco and the Byron Jackson Company of Los Angeles. Assembly of the first pump was started by the Bureau of Reclamation on July 27, 1950, and it is planned to have the first six pumps installed by the autumn of 1952. The pumps, Fig. 8, are vertical-shaft, single-impeller, centrifugal units, each having a rated capacity of 1350 cusecs at a 310ft head. They are guaranteed to have an efficiency of 87 per cent. Their maximum capacity is 1600 cusecs at a 280ft head. To obtain certain basic data required for the design of these pumps, an extensive testing project was conducted during 1939 and 1940 at the Hydrodynamic Laboratory of the California Institute of Technology. Several pump manufacturers and the Bureau of Reclamation submitted models for testing purposes. These models included single, double and triple-volute pumps and pumps with diffuser vanes and adjustable guide vanes. Furthermore, several designs of suction elbows and intakes were tested in the laboratory. From these preliminary tests it was found that the prototype speed could be increased from 150 to 200 r.p.m., which permitted reducing the physical size of the units with a corresponding saving in cost. A design of a short-radius suction elbow was found to perform as well as a long-radius or vaned elbow and was used in the final design. After awarding the contract for the first six pumps in 1946, further model tests were made. These, combined with mechanical design studies, led to the selection of a five-vane diffuser casing, with a central vane running to the discharge flange. The central vane is about as thick as the shell and is welded to it.

The impeller is 5ft 8½in high and, at the top, is 14ft in diameter. It is a seven-vane, single-piece steel casting weighing approximately 27 tons. The spiral casing, Fig. 6, which has a maximum overall diameter of 29ft, was designed to have a cast steel centre with five diffuser vanes welded to the outer steel plate volute. These vanes serve to form diffusers to reduce the velocity of the water leaving the impeller and to facilitate the transmission of part of the foundation load through the casing. The casing is fabricated in two sections and assembled in position at the pumping plant. The smaller section weighs 65,000 lb and the larger discharge section weighs 70,000 lb. The maximum diameter of the water passage is 7ft 5in.

The shaft is in two sections. The motor shaft is 24ft 5in long and the pump shaft, Fig. 9, is 16ft 10in long, the impeller being attached to the lower end. The two sections of shaft are bolted together at the 1220ft elevation, using sixteen bolts, which, with nuts, weigh approximately 75 lb each. The average motor shaft diameter is 28in. The pump shaft diameter is 27in. Both sections of shaft have a central 6in diameter hole through the full length. Radiographic inspection through these holes insures that there are no imperfections in the forged steel shafts. The entire rotor weighs approximately 338,000 lb and revolves at a design speed of 200 r.p.m.

(To be continued)

The Engineering and Marine Exhibition

No. IV—*(Continued from page 326, September 14th)*

A FURTHER selection of plant and equipment shown at the recent Engineering, Marine and Welding Exhibition at Olympia is described herewith.

B. Rhodes and Son, Ltd.

On the stand of B. Rhodes and Son, Ltd., of Queen Street, Romford, Essex, there was shown for the first time a new safety valve, invented by Mr. W. R. Sergeant, which the company recently put into production. This valve is made in three models—deadweight, lever and weight, and lever and spring operated—and it is particularly intended for vacuum apparatus in chemical and industrial plant. Its design is such that, whilst it provides an effective prevention against explosion, it maintains the high standard of vacuum required in processing plant.

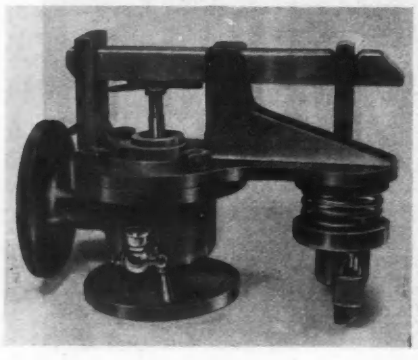


FIG. 38—VACUUM SAFETY VALVE—RHODES

In Fig. 38 we illustrate one of the lever and spring-loaded valves and the arrangement of the valve itself can be seen in the diagram, Fig. 39. The main body of the valve is provided with two standard flanged members for coupling to the vacuum vessel and the connection to atmosphere. The main spindle is carried in a long bearing machined in the top cover plate and a coned head formed on its lower end rests on a deep seating. The spindle is a close machined fit in the cover and a cup at the top of the bearing forms a lubricant well.

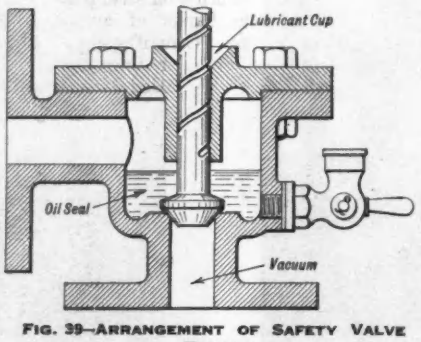


FIG. 39—ARRANGEMENT OF SAFETY VALVE—RHODES

The spindle cone is lapped into its seating and, to ensure that there is no loss of vacuum when the valve is in service, the lower part of the valve chamber is filled with slab oil, liquid paraffin or other liquid suitable to the process. This level of sealing liquid is maintained by a connection to any suitable source through a small cock in the body. In order to ensure that the valve will not stick and fail to rise when an emergency occurs, spiral grooves are cut in the spindle to give a free flow of oil round the bearing surface from the lubricating cup. Free operation of the valve can be easily checked at regular intervals by turning the spindle by a star-wheel at the top.

No pins are used in the assembly of the weight or spring links of the safety valve. The anchored end of the main lever is simply coupled by a hollow link to a hook on the valve cover and its free end is kept in alignment by a yoke member. This yoke member and the spring loading plate are an integral part of the valve cover in the unit illustrated and in the lever and weight unit it is a separate unit bolted to the cover. To prevent any tendency to stick, all connections between the links and levers are made through knife-edges.

Standard valves of this design are being made in a range of sizes from ½in to 3in, with bodies and covers of zinc-free bronze and stainless steel spindles. Where under certain conditions of corrosion it is necessary to protect the bronze bodies of the valves, liners, which also form the valve-seatings, are pressed into the bodies. These liners and the valves can be supplied in monel, nickel, iconel or stainless steel if required.

Russell Newbery and Co., Ltd.

Among the exhibits shown by Russell Newbery and Co., Ltd., of Dagenham, were a six-cylinder marine propulsion diesel engine developing 120 b.h.p. at 1200 r.p.m. and having a fluid operated reverse and 2 to 1 reduction gear; a 60kW marine generating set; a marine auxiliary set, consisting of a generator, pump and air compressor, and a power pack.

There was also a new single-cylinder, horizontal, four-cycle, diesel engine, illustrated in Fig. 40, developing 5 b.h.p. to

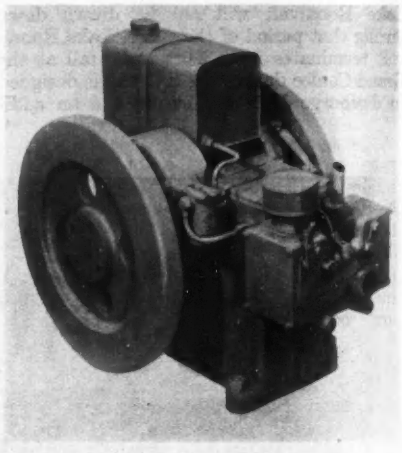


FIG. 40—HORIZONTAL DIESEL ENGINE—RUSSELL NEWBERY

7 b.h.p. at 1000 to 1500 r.p.m., having a bore of 3⅜in by 4½in stroke. The strongly ribbed crankcase is of cast iron, it carries a wet renewable liner and the lower portion forms a large capacity oil sump. The cylinder head is of high grade iron and incorporates the combustion system developed by the company. It carries the inlet and exhaust valves, which are arranged horizontally, and are push-rod operated through rocker levers.

A piston of special aluminium alloy is provided and fitted with three compression and two scraper rings. An "H" section alloy steel drop stamping is used for the

connecting-rod, which is drilled for lubrication to the high grade phosphor bronze small-end bush and has the big-end split at an angle to facilitate removal through the bore. The crankshaft is a steel stamping incorporating an integral balance weight, and a drilled oilway carries lubricating oil to the big-end bearing, the top half of which is of copper-lead and the bottom half of steel, white-metal lined. The steel camshaft is disposed horizontally and driven through a pair of helical gears from the crankshaft.

A totally enclosed fuel pump is mounted and the pintle pattern nozzle has a large orifice and is self-cleaning. Lubrication is maintained by a large capacity gear pump and cooling can be arranged by a number of methods. Twin flywheels are provided and have holes suitable for fitting an extension shaft. The engine, which has overall dimensions of length, 31in; height, 24·5in and a width of 19in, weighs 560 lb when dry.

Thorn and Hoddle, Ltd.

The oxy-acetylene welding and metal cutting equipment made by Thorn and Hoddle, Ltd., of 115, Victoria Street, S.W.1, includes a new tube cutting machine and end beveller which is of simple design and can be used by unskilled labour on working sites. This unit, illustrated in Fig. 41, cuts tubes up to 6in diameter.

It consists of two units, a combined cutting head and support and a separate support for the tail end of the tube. The cutting head is mounted on a substantial base and carries two sets of twin pipe support rollers, which can be spaced in a vee housing according to the diameter of the pipe. The shaft on which one pair of rollers is mounted is driven through bevel gears by the crank handle clearly visible in the photograph. These driven rolls have serrations cut round their circumferences and the weight of a pipe upon them provides sufficient frictional grip to turn the pipe. A column rigidly supported in the base member carries a sliding bracket, on which the cutter is clamped to project the cutting flame at any required angle on the tube. When the bracket is located to suit the tube diameter it is fixed firmly in position by two clamps. A protractor on the bracket is used to set the angle of the cutter flame.

The support unit for the tail end of the tube has a similar pair of twin support rollers to the cutting head unit. Like the head unit, its rollers are mounted in a vee housing and, to accommodate different tube diameters, the rollers on the rear portion of the housing are moved up or down to register in appropriate slots. When the two units are accurately aligned, with the tube supported on all eight rollers, it requires but little effort to turn the tube whilst cutting proceeds.

The complete cutting set is supplied complete in a steel case, 11in square by 15in long and weighing only 50 lb.

Ruston and Hornsby, Ltd.

On its stand, Ruston and Hornsby, Ltd., of Lincoln, showed a number of new and recently developed engines, including the Ruston-Paxman "Y.L." engine as a rail traction unit, the Ruston "Y.E.M." engine, for marine propulsion, the Ruston "L.H.T." locomotive and a Paxman V.6R.P.Hm marine engine.

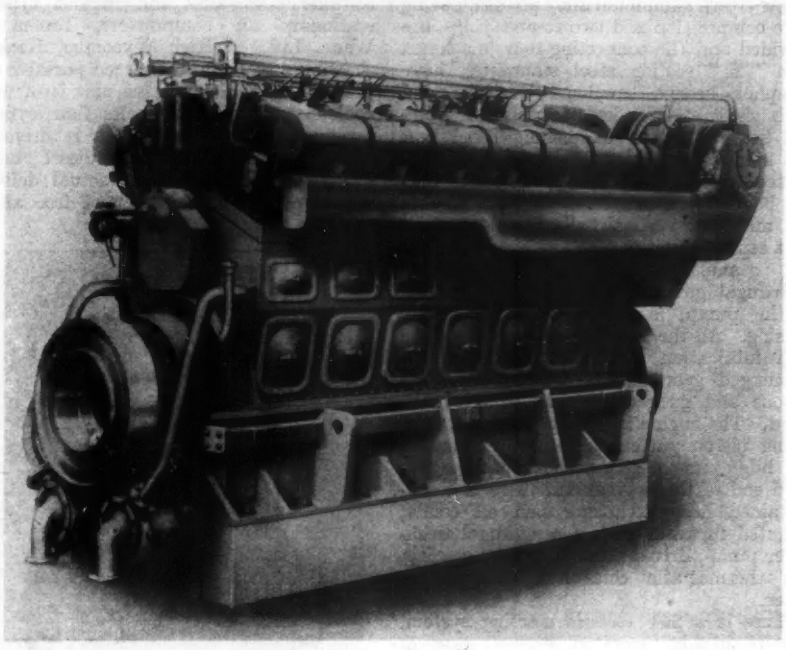


Fig. 42—Y.L. Engine—Ruston-Paxman

The "Y.L." engine on view, and illustrated in Fig. 42, was a four-cycle, compression ignition, twelve-cylinder, pressure-charged vee form unit, having a bore of 9¾in by 10¼in stroke and developing 1125 b.h.p. at 750 r.p.m. The housing and cylinder blocks are of fabricated steel plate, stress relieved, and the banks of cylinders are arranged at 45 deg. Centrifugally cast iron chromium-plated cylinder liners are fitted and carried in galvanised steel water-jackets. The cylinder heads are separate iron castings, each carrying two exhaust and two inlet valves, one air starter valve and a fuel injector. There is a centrally located camshaft carried in white-metal lined steel-backed bearings and driven by a roller chain, which operates the valves through roller pattern cam followers, short push-rods and rocker arms.

Aluminium alloy pistons, having four compression and two oil control rings, are fitted and the connecting-rods, machined from "H" section steel stampings, have phosphor bronze small-end bushes and steel-backed, copper-lead big-end bearings. The crankshaft is forged from 1 per cent nickel steel and is oil hardened and tempered, drilled for pressure lubrication and carried in bearings of copper-lead lined steel shells. The engine governor is of centrifugal hydraulic servo pattern, using lubricating oil pressure to control the fuel pumps, which are operated by a camshaft driven through helical spur gearing from the main camshaft.

Pressure lubrication is maintained by a gear pump and there is a hand pump for initial lubrication, while two centrifugal

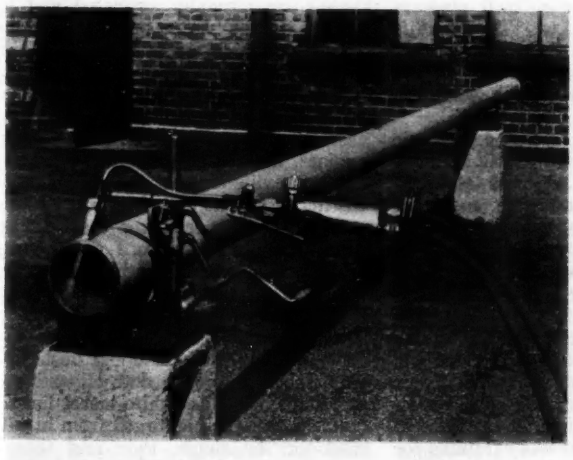


Fig. 41—Tube Cutting Machine—Thorn and Hoddle

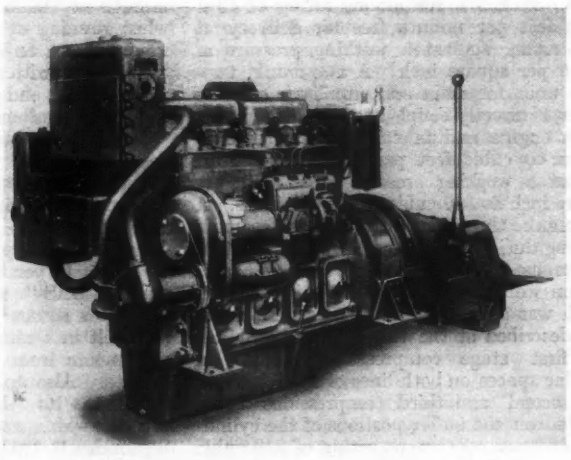


Fig. 43—Y.E.M. Engine—Ruston and Hornsby

cooling water circulating pumps are fitted at the free end of the engine. Starting is by compressed air applied direct to all cylinders and controlled by a distributor.

The "Y.E.M." marine unit on view (Fig. 43) was a four-cylinder, four-cycle, compression ignition engine, which has a rated brake horsepower of 75 at 1500 r.p.m., the service brake horsepower being 67·5. The crankcase and cylinder block are of monobloc construction in close-grained cast iron and renewable wet liners are fitted. High-grade cast iron is used for the cylinder heads, which carry overhead inlet and exhaust valves of heat-resisting steel, valve gear and fuel injectors. Low expansion, high-speed pattern, hollow crown aluminium alloy pistons, having three compression and two scraper rings, are provided and the connecting-rods, machined from "H" section steel stampings, have phosphor bronze small-end bearings and prefinished steel-backed, copper-lead big-end bearings. The underslung crankshaft is a steel stamping and is carried in steel-backed copper-lead bearings, the main journals being 4½in diameter.

A monobloc vertical helix pump, containing a separate unit for each cylinder, supplies fuel to multi-hole nozzle injectors and a centrifugal governor, driven from the end of the pump, is mounted on the pump housing. All the main bearings are supplied with lubrication oil under pressure by a submerged gear pattern pump, while the pistons and gudgeon-pins are splash-lubricated. The engine is equipped with double-acting piston pattern sea-water circulating and bilge pumps, gear-driven from the forward end of the engine, and there is a self-contained heat exchanger and oil cooler, mounted forward, with a centrifugal fresh-water pump, driven through helical gearing, and thermostatic control of the cooling water.

There is a 24V electric starting system, a mechanically operated reverse gear of bevel differential design and double helical reduction gear, arranged for sea-water cooling.

Compressors

Many of the compressors which were exhibited have been selected from the standard production ranges of their makers as typical of the units which are available for a wide range of applications.

The Hamworthy Engineering Company, Ltd., of Poole, Dorset, showed four single-acting air compressors particularly designed for engine starting duties. One of these machines, which was sectioned to show its arrangement, is a single-crank, tandem, two-stage unit for emergency and starting purposes. It has a continuous rating of 13·1 cubic feet per minute free air delivery at 1000 r.p.m. against a working pressure of 450 lb per square inch. A two-crank, two-stage unit, for main and auxiliary starting duties, is directly coupled to a single-cylinder steam engine and is continuously rated to deliver 60 cubic feet per minute of free air against a working pressure of 450 lb per square inch at 550 cubic feet per minute. A two-crank, three-stage compressor for main starting duties, shown on the stand, is fitted with transparent crank case covers and has its motion work illuminated. In this machine, which was also shown at the last exhibition and described at the time in these columns, the first stage compression occurs in annular spaces on both lines of motion work, the second and third compressions being effected on the buffer portions of the cylinders. It has a continuous rating of 246 cubic feet per minute of free air delivered against a working pressure of 600 lb per square inch at 500 r.p.m.

On the stand of Arpic Engineering, Ltd., Queenslie Estate, Glasgow, a selection of the firm's range of portable air compressors and examples of its stationary air compressors are to be seen. All of these compressors are of two-stage, air-cooled design, complete with intercooler. In the portable range the plants are fitted with an oil-operated clutch with simple push-button control, and the maker's "Fuelmiser," which controls the diesel engine speed in proportion to the air consumption at a constant pressure.

Together with examples of its wide range of pneumatic tools and various types of stationary air compressors, Broom and Wade, Ltd., of High Wycombe, Bucks, is showing a recently introduced portable compressor. This sleeve-valve unit is of water-cooled vee design, with its four cylinders arranged in two banks. It is driven by a Gardner, five-cylinder diesel engine, developing 65 b.h.p. Its actual delivered capacity is 210 cubic feet of free air per minute at 100 lb per square inch pressure when running at 1200 r.p.m. The plant is mounted on an all-steel frame chassis of rigid design, with sprung axles and pneumatic tyred wheels, and provided with drawbar and full trailer equipment.

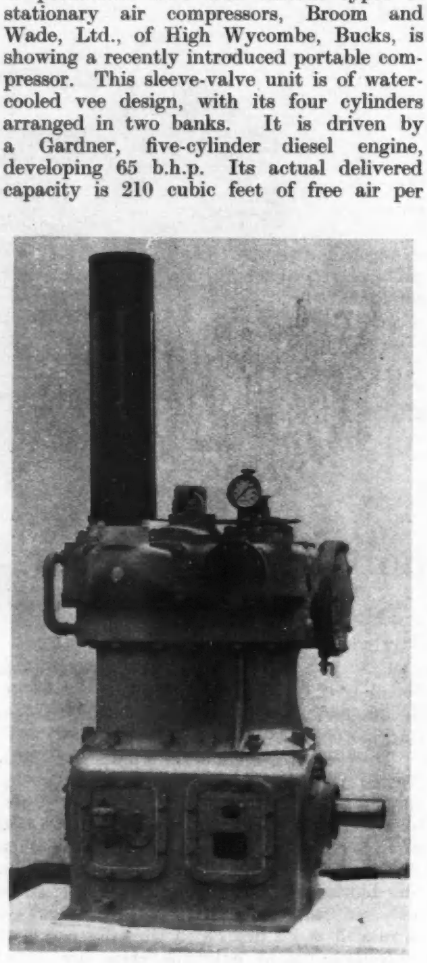


Fig. 44—Two Stage Air Compressor —Reavell

Vertical double-acting, water-cooled air compressors of two kinds exhibited by Worthington-Simpson, Ltd., of Newark-on-Trent, are suitable for engine, motor or belt drive at up to 1000 r.p.m. The two-stage "DA" type is designed for pressures up to 150 lb per square inch and the single-stage "DAS" type for pressures up to 50 lb per square inch. These compressors are built in a range of sizes with piston displacements from 100 to 900 cubic feet per minute. Also to be seen upon this firm's stand was its "KH" type air-cooled compressor, which was described in our issue of September 5, 1947, when it was exhibited for the first time. This compact three-cylinder, radial, three-stage unit is built for pressures of up to 1000 lb per square inch.

The main exhibit on the stand of Alley and Maclellan, Ltd., Polmadie, Glasgow, was one of the firm's series "45.B.10" air compressors, which has a capacity of 1000 cubic feet of free air per minute at a working pressure of 100 lb per square inch. This two-stage, two-crank unit is of the double-acting crosshead type with an intercooler provided between the stages. It is direct coupled to a 200 b.h.p. electric motor. Compressors in this range can be provided in capacities from 428 cubic feet per minute up to 6000 cubic feet per minute.

A compressor having a capacity of 50 cubic feet of free air per minute at a working air pressure of 100 lb per square inch was exhibited as an example of the firm's steam-driven units, which can be provided in various sizes with superimposed steam cylinders.

A new machine upon the stand of Reavell and Co., Ltd., of Ipswich, was "BSCA.9" compressor, illustrated in Fig. 44. This vertical, single-acting, two-stage machine is designed to compress 310 cubic feet of free air per minute to 100 lb per square inch when running at 480 r.p.m. Its first-stage cylinder is 14½in bore and the second-stage cylinder 8½in bore, both having a stroke of 8in. The machine has an air-cooled barrel with a water-cooled cylinder head, which is fitted with a heat interchanger. A smaller machine of 200 cubic feet per minute capacity is also made by the firm to similar designs and other sizes are contemplated. All of these machines will have cylinders built separate from the crank case, so that, if required, it is possible to substitute two cylinders of equal bore for single-stage working to give an increased capacity for lower pressures.

Other Reavell machines exhibited include a four-stage compressor for pressures up to 3500 lb per square inch, examples of three types of rotary compressor, and three rotary air motors specially designed for starting internal combustion engines.

A number of sizes and types of compressors for refrigeration plant, shown by J. and E. Hall, Ltd., of Dartford, Kent, include a new 5in bore by 4in stroke eight-cylinder unit and a unit for use with ammonia, which has a bore of 9in by 9in stroke. Amongst the smaller units on this stand is a four-cylinder refrigerating compressor of 3in bore by 2½in stroke.

Ailsa Craig, Ltd.

Ailsa Craig, Ltd., of Ashford, showed single-cylinder and twin-cylinder industrial engines and a range of marine units of 10 to 60 b.h.p. having one to six cylinders. The marine engines of vertical four-stroke design are normally aspirated and have a bore of 4½in, a stroke of 5½in, a b.m.e.p. of 80lb per square inch, and Ricardo "Whirlpool" combustion chambers of stainless steel.

The crankcase is a monobloc casting carried up to the cylinder heads, the sump being cast integral on the single and twin-cylinder engines, and detachable on the three, four and six-cylinder engines. A "Meehanite" casting forms the cylinder head and includes renewable valve seats for the tulip pattern "Silichrome" steel valves. Low-expansion aluminium alloy pistons with four compression and two scraper rings are fitted and have hardened and ground steel gudgeon pins. The connecting-rods are high-tensile steel drop forgings with small-end bushes of chill cast phosphor-bronze and big-end bearings of gunmetal shells, white-metal lined. The crankshaft, which is forged from high-tensile steel for the single, twin and six-cylinder models and a special "Meehanite" casting for

the three and four-cylinder engines, has a steel shell, white-metal—lined bearing on each side of each throw.

The valves are operated by push rods from a solid steel camshaft having a silent gear drive. The fuel pump is gear driven from the camshaft, cooling water is circulated by a gunmetal plunger pump, and forced lubrication is maintained by a gear wheel pump. The engines have a balanced epicyclic reverse gear with hard steel phosphor-bronze multiple-plate clutches.

Audley Engineering Company, Ltd.

A prominent exhibit amongst the wide range of lubricated plug valves for all classes of work which was shown by the Audley Engineering Company, Ltd., of Newport, Shropshire, was the 16in full area opening "Class 600" valve, illustrated in Fig. 45. This valve is one of a large number the firm is making for installation on the new crude oil pipe-line of the Iraq Petroleum Company, Ltd., between Kirkuk and the Mediterranean coast. This valve has its ends arranged for butt welding into the line and follows the "Hypreseal" design.

In this design of valve the plug is seated by a ball thrust and resilient steel cover, through which the amount of lift of the plug and the pressure with which it is thrust into its seat are closely controlled through a screw at the base. The operating shank is threaded and screwed into the body and it is connected to the plug through a universal coupling, the arrangement being such that the plug is independent of outside loads. The threads of the shank are sealed against leakage by means of a plastic packing.

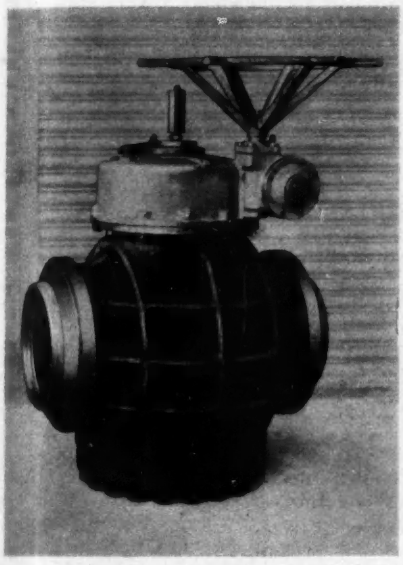


Fig. 45—16in. Valve—Audley

Lubricant is introduced through a threaded hole at the top of the shank and compressed by a screw. This lubricant passes into a series of grooves round the base and up the sides of the plug. Any leakage past the threads of the shank is in the form of lubricant and not line fluid.

By means of a working model on the stand the firm showed the properties of compressibility and expansion of its new range of "Hypermatic" valve lubricants.

Hamworthy Engineering Company, Ltd.

Amongst the pumps seen upon the stand of the Hamworthy Engineering Company, Ltd., of Poole, was a new horizontal spindle external bearing rotary gear pump, developed primarily for handling fluids with little or no lubricating value over a wide range of viscosity. These pumps, known as the "R.P.O." series, are designed for a maximum discharge pressure of 100 lb per square inch and can handle fluids with the viscosity of petrol up to 2000 secs Red. No. 1, at maximum operating speeds. At lower speeds, the makers state, the pumps can handle any fluid which will flow through a pipe.

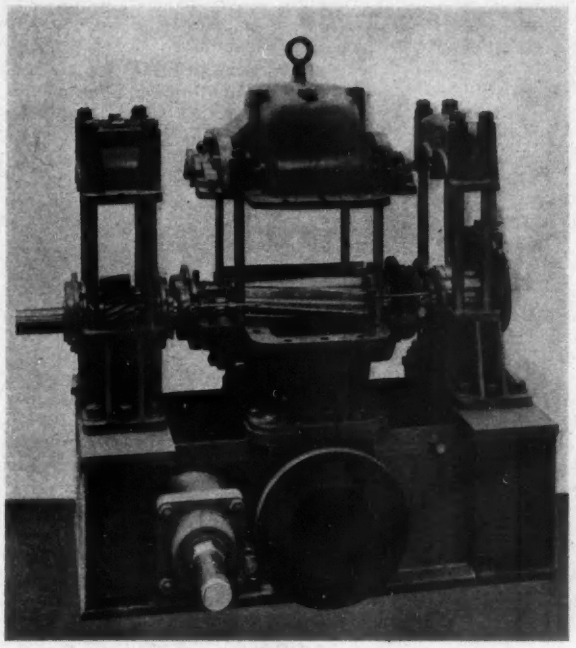


Fig. 46—"R.P.O." Gear Pump—Hamworthy

The arrangement of the pump can be seen in Fig. 46, where it is shown with the top half of the casing and bearings raised.

The base plate, which is normally of fabricated steel or cast iron, forms a rigid attachment between the pump unit and the driving motor. It is designed to carry the suction and delivery branches and take the weight of any unsupported pipework in order to eliminate the possibility of distortion. Where the driving unit is remote from the pump a short underbase of sufficient length to accommodate the pump unit and bearing housings is fitted.

The suction and delivery connections between the base plate and the pump unit form a seating, on which the pump unit is located by means of dowel pins. The separate bearing housings at each end of the pump unit are also bolted to machined faces on the top of the base plate and located by means of dowel pins. In the bearing housing at the driving end of the pump are housed the gears, which transmit the drive between the driving and the driven shafts.

A pump casing of cast iron, cast steel or gun metal is split in the plane of the rotors and spindles. The halves of the casing are located by fitted bolts, the metal-to-metal joint being surface ground and hand scraped prior to machining the rotor bores. The gland housings at each end of the pump casing, the timing gearcase and bearing housing are also split.

Single-helical pump rotors can be manufactured in bronze, high-duty alloy iron, case-hardened steel or stainless steel as required. These rotors are shrunk on to alloy or stainless steel spindles, which are ground on all wearing surfaces. Each spindle is carried on two spherical roller bearings at each end, one of the bearings at the free end being located axially in the housing and on the shaft to provide the requisite axial clearances and absorb any unbalanced axial load between the opposed single-helical pump rotors and timing gears. Between the two bearings at the driving end of the pump are single-helical timing gears, which have ground tooth profiles and are manufactured in flame-hardened or case-hardened steel.

The four glands of the pump can be fitted with face-type mechanical seals or conventional packed stuffing-boxes as required. If stuffing-boxes are fitted arrangements can be made to supply sealing oil or fluid to a lantern ring in the centre of the box at a pressure above that in the pump suction. Each gland, whether of the mechanical seal or conventional type, is subjected to suction pressure only. A dashpot high-lift spring-loaded by-pass valve, housed in the base plate, protects the pump motor and pipeline equipment against overload.

Traughber Filter Company, Ltd.

Equipment for the collection and disposal of industrial dusts, fumes and mists is shown in some detail by means of models by the Traughber Filter Company, Ltd., of 41–42, Parliament Street, London, S.W.1. This firm specialises in the design and development of wet, semi-wet and dry systems for special applications.

The principle of this company's froth flotation filter is based on the efficient wetting of dust particles. In this plant the dust-laden air or gas is forced to impinge upon a water-sprayed plate causing the precipitation of the larger particles. The air is then directed through finely atomised water sprays (if necessary, with the addition of a special wetting agent), which encase every dust particle in a film of fluid. The then partially cleaned air is bubbled through a water bath, which causes the remaining dust to settle out. The cleaned air then passes through layers of porcelain rings, which absorb any moisture carried over, so that the fan diffuses only clean dry air to atmosphere. This type of filter is self-cleaning and the pressure drop across the unit remains constant with steady conditions maintained at the point of dust nuisance. No mains water is used, as the initial water charge is recirculated by a pump.

This process may be used for the treatment of hot gases without the necessity of precooling. In it the dust is collected as sludge, and special continuous sludge removal apparatus is arranged to discharge at any convenient point.

In the company's semi-wet or dry-wet filter a high efficiency cyclone eliminates the coarser particles and the dust-laden air or gases carrying the finer particles is passed

through a secondary wet stage, similar in principle to the wet filter.

For the dry collection of valuable dusts the firm uses high-efficiency cyclones, which may be arranged singly, in nests or in parallel, with multi or common outlets.

Crofts (Engineers), Ltd.

Power transmission equipment of all kinds and sizes displayed upon the stand of Crofts (Engineers), Ltd., of Thornbury, Bradford, included geared motors and reduction units, split taper bushed vee pulleys, the "Airflex" clutch, and the "BOM-L" clutch, together with examples of fabricated steel constructional work.

The "Airflex" clutch, which was described in detail in our issue of August 11, 1950, is an air-operated unit of such a design that by small modification it can be adapted for an expanding or contracting clutch or an effective brake for a wide range of industrial applications. It consists essentially of an annular rubber bag which, on being expanded by compressed air, moves friction blocks into contact with a driving or a driven member to transmit power or apply a braking force. These clutches are made in various sizes by the firm, and all have a common feature in that they are smooth in operation, of light weight, and once installed require little or no maintenance.

The "BOM-L" design of clutch is widely used on machine tools and is made in eight sizes to transmit from 0·6 to 15 h.p. at 100 r.p.m. This clutch is ball operated and it employs the rolling motion of hardened steel balls on hardened and lightly loaded surfaces. It is a compact little unit and requires no pressure to hold once in the engaged or disengaged position. The makers point out that the clutch is so designed and constructed that it does not require any adjustment whatsoever.

Plus-Gas Generator Company, Ltd.

There was exhibited for the first time a fluid for loosening corroded parts of heavy machinery by initiating rust dehydration, which has been introduced by the Plus-Gas Generator Company, Ltd., of 89, Cromwell Road, London, S.W.7. The firm showed a hand-forged telpher-line pulley which had been lying on a scrap heap for many years, and from which, it was stated, the corrosion binding the pulley wheel to the spindle had been completely removed, and the wheel made free to rotate in a matter of four or five minutes after an application of "Plus Gas Formula 'A,'" as the fluid is known.

The attachment nuts on this unit when released had in each case a clean and undamaged thread, and only approximately fifteen minutes were required with the fluid to make the pulley suitable for reinstallation.

This dismantling fluid is claimed to be equally efficient in its action on non-ferrous metal corrosion, including carbon deposits. It is a non-acid preparation, has no corrosive action of its own, and is non-injurious to the operator or his clothing. Fluid can be applied by spraying with a hand pressure can, or, for heavy corrosion of small parts, by immersion.

No special treatment is required prior to painting of equipment previously treated with the fluid, except in the case of cellulose or synthetics, when the surface to be painted should be cleaned with white spirits.

A complementary fluid shown was "Plus Gas Formula 'B,'" which, when applied to ferrous or non-ferrous metals by spraying, painting or dipping, gives a transparent protective coating. The coating can be easily removed by washing with any liquid with a spirit base.

G. and J. Weir, Ltd.

G. and J. Weir, Ltd., of Glasgow, showed a few examples of its engine-room auxiliary machinery, including a pair of modern direct-acting pumps, a two-stage two-crank motor-driven air compressor, having a working pressure of 450 lb per square inch, and an ammonia compressor for refrigeration service. Two interesting and contrasting exhibits on the stand served to illustrate effectively the remarkable development in boiler feed pumps during the last forty years. The items in question were a pair of direct-acting boiler feed pumps, dated 1912, as fitted in the Cunard liner "Aquitania," and alongside them a modern turbine-driven feed pump.

The pair of pumps, including valve box and air vessel, weigh about 8 tons and each is rated to deliver 14,200 gallons per hour. The pump end is 13in in diameter and the steam cylinder has a diameter of 18½in by 27in stroke; it gives ten double strokes per minute and takes saturated steam at 210 lb per square inch. The pair of feed pumps was one of several fitted on board the "Aquitania" and each pump is in excellent condition, after service in the ship since 1914 until last year, when the liner went to the shipbreakers after steaming 3,000,000 miles. The turbine-driven pump of present day design delivers 15,000 gallons per hour at 6500 r.p.m., taking steam at 250 lb per square inch and weighs 15 cwt.

Babcock and Wilcox, Ltd.

The stand taken by Babcock and Wilcox, Ltd., of Farringdon Street, London, E.C.4, was divided into two main sections to show the marine and the land sections of the firm's activities. A majority of the equipment displayed has already been dealt with in these columns and is well-known to all engineers.

In the marine section models were used to show the arrangement of the firm's integral furnace marine boiler; single-pass marine boiler; divided pass controlled superheat marine boiler, and the operation of its "Cyclone" steam superheater. To supplement this display, photographs and models of vessels equipped with these boilers were arranged adjacent to the working models.

Shown amongst the land steam-raising plant on the other side of the stand was a working exhibit of the Babcock soot-blower and Lockheed-Babcock control cubicle; a spray attemperator and control panel; a Clarkson exhaust heater and exhaust heat or oil-fired thimble-tube boiler for marine service; and a model of a large "Radiant" control station boiler with pulverised fuel-firing.

A.E.C., Ltd.

The exhibits on the stand of A.E.C., Ltd., of Southall, included several examples of the company's six-cylinder, indirect-injection oil engines used in various forms as power units. The marine engine embodies a Ricardo "Comet" combustion chamber, has a bore of 120mm by 142mm stroke, a compression ratio of 16 to 1, and develops 100 b.h.p. at 1500 r.p.m. The crankcase, which is of fine quality, close-grained cast iron, is in two halves and the cylinder block is a one-piece casting in alloy iron fitted with centrifugally cast alloy iron dry liners. Two interchangeable cylinder heads are provided and carry the valve rocker shaft assembly, valves and injectors.

The heat-treated aluminium alloy pistons have three compression and two scraper rings and fully floating hollow gudgeon pins located endwise by circlips. The connecting-rods are manufactured from "H" section steel stampings and have a phosphor-bronze small-end bush and big-end bearings of lead-bronze steel backed. A heat-treated, high-tensile alloy steel drop forging forms the crankshaft, which is carried in seven steel shell pattern bearings with top and bottom halves lined with white metal and lead-bronze respectively.

The valve gear is operated by rockers and push-rods actuated by mushroom-shaped tappets having chilled iron faces, from a case-hardened steel camshaft having five intermediate bronze bushes. A positive action plunger fuel lift pump feeds the multi-plunger pattern cam-operated fuel injection pump which delivers fuel to pintaux fuel injectors. Dry sump lubrication is employed and the system is maintained by one of a pair of submerged gear pumps driven from the camshaft by a single shaft and skew gear. The second pump draws the used lubricating oil from the crankcase. Each engine has two centrifugal water pumps, one for fresh water for engine cooling, and the other for circulating salt water through the oil cooler. Both pumps are driven through helical timing gears.

There is a 24V axial starter motor and a 24V dynamo and a duplex clutch mechanism transmits the drive through a reduction gearing of 1·96 to 1.

F. Perkins, Ltd.

F. Perkins, Ltd., of Peterborough, showed a number of its well-known six-cylinder engines employed as power units, and several marine engines, including a new four-cylinder diesel engine.

The "P 4 M" is a vertical, four-cylinder-in-line, four-stroke, high-speed compression-ignition engine, having a bore of 3½in by 5in stroke, and a rated output of 43 b.h.p. at 2000 r.p.m. Nickel-chrome cast iron alloy is employed for the combined cylinder block and crankcase casting, and high-duty dry liners are fitted. The cylinder head is a chromium iron casting and carries tappets, rocker gear, and two overhead valves. Special light aluminium alloy pistons are fitted, provided with three compression rings, and two scraper rings, one of which is above and the other below the fully floating gudgeon pin. High-quality steel is used for the connecting-rods and the crankshaft is forged from nickel-chrome molybdenum steel, heated and hardened on the bearing surfaces, and supported in bearings on either side of each cylinder. The main bearings are copper-lead-lined, steel-backed shells.

A triple roller chain with automatic tensioner drives the camshaft and the shaft of the fuel pump, which delivers fuel to atomisers having two-hole nozzles. High-pressure forced lubrication is maintained by an oil pump driven through spiral gears from the fuel pump drive shaft, and mounted at the rear of the engine is an oil cooler, one section of which deals with engine oil and the other with gearbox oil. A self-priming, positively driven, gear pattern water pump is provided and starting is by a 24V axial motor. The reverse gearbox is bolted directly to the power unit, and the clutches are operated by oil pressure supplied by an integral pump.

The engine, which weighs 770 lb as a direct-drive unit, has four facings with supporting feet, and has a maximum installation angle of 12 deg.

(*To be continued*)

A 500 h.p. Diesel-Mechanical Locomotive

FOUR standard gauge 0–8–0 diesel-mechanical freight locomotives of new design are being built by the Hunslet Engine Company, Ltd., of Jack Lane, Leeds—three for Peru and one for this country. The first of these engines, which we illustrate on this page, has been undergoing trials on steeply graded branches of British Railways prior to delivery to the Peruvian Corporation for the Paita/Piura Railway. In Peru the locomotive will be used to haul freight trains over a 62 miles length of line with a ruling gradient of 1 in 29 about 2½ miles long. In its tests in this country the locomotive has been engaged in hauling trains up to 700 tons over ruling grades of 1 in 133, up to 515 tons on grades of 1 in 60 and up to 435 tons on 1 in 48/50 grades.

In the course of its trials in this country, which were held on British Railways by the courtesy of Mr. R. A. Riddles, member of the Railway Executive, the locomotive was tried first in heavy coal shunting at Stourton down yard for a month. Now for the past few weeks it has been engaged in hauling freight and mineral trains on the particularly difficult sections of line between Stourton, Guiseley and Yeadon in the Leeds district. Loads have been hauled up to the limit of those scheduled for the 2–8–0 steam locomotives of class "8 F," and on certain occasions loads have been handled that would have required an "8 F" piloted by a class "3 F" 0–6–0 engine. During this running the locomotive has proved very steady and has run without any trace of wheel slip throughout the 1 in 60 and 1 in 48/50 grades. Speeds up the 3 miles of curved 1 in 60–53–62 line have been maintained unwaveringly at 6 m.p.h. with 460/470 tons trailing, and 5¾/6 m.p.h. up curved 1 in 48/50 line with 435 tons trailing, both under conditions of greasy rails.

The leading particulars of the locomotive are as follows :—

Diameter of coupled wheels	4ft		
Wheelbase	13ft 6in		
Height overall	13ft		
Width overall	8ft 8in		
Length over buffer beams	29ft 9in		
Maximum power of engine	500 h.p. at 1375 r.p.m.		
Normal speed :			
First gear	4½ m.p.h.		
Second gear	6 m.p.h.		
Third gear	9 m.p.h.		
Fourth gear	14¼ m.p.h.		
Fifth gear	21 m.p.h.		
Sixth gear	33 m.p.h.		
Weight in working order	55 tons		
Maximum axle load	14 tons		
Normal tractive effort :			
First gear	35,400 lb		
Second gear	26,600 lb		
Third gear	17,700 lb		
Fourth gear	11,200 lb		
Fifth gear	7600 lb		
Sixth gear	4830 lb		
Ratio, adhesive weight ÷ tractive effort	4·63 to 1 in second gear		
Minimum radius of curve locomotive will traverse without train	325ft		
Load engine will :	Level	1 in 100	1 in 50
Start and haul in first gear (limit of 4 : 1 adhesion), tons	1650	700	430
Haul in second gear, tons ...	1650	700	410
Haul in third gear, tons	1420	455	255
Haul in fourth gear, tons ...	875	265	135
Haul in fifth gear, tons	580	165	75
Haul in sixth gear, tons	345	85	30

(Loads hauled are based on 18 lb per ton starting resistance and 12 lb per ton running resistance.)

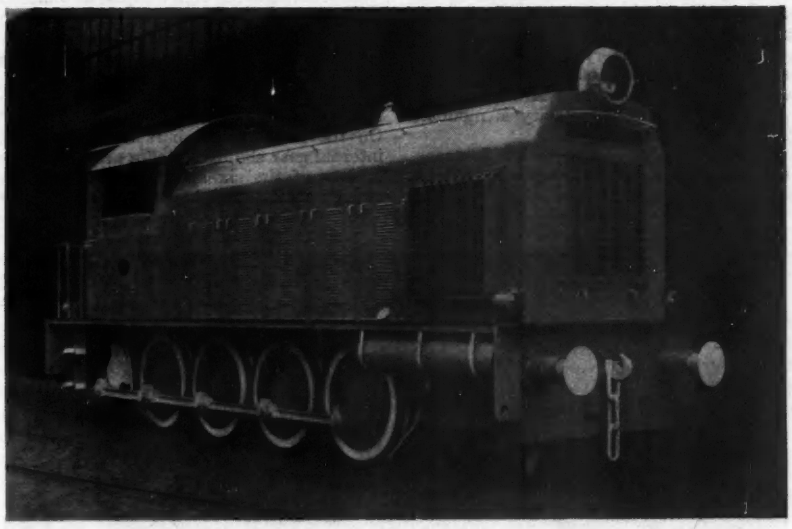
The locomotive has 48in wheels spread over a wheelbase of 13ft 6in, and in full working order its weight is 55 tons and the maximum axle load 14½ tons. Its wheelbase and axle load were arranged to suit the conditions on the Paita–Piura Railway, and the top speed of 33 m.p.h. was also chosen to suit the operating conditions on that line.

Built up on a plate frame structure of riveted and bolted construction, the whole locomotive below the running plate level is of particularly robust construction in order to withstand the hard knocks of shunting and freight service, and maintain the alignment of engine, driving shaft and gearbox. The side buffers and link couplings shown in the illustration are for the trial service on British Railways, and centre couplers are to be fitted for work in South America. The suspension system comprises underhung laminated springs compensated in two groups down each side. The axleboxes and driving and coupling-rod crankpins have Ajax grease lubrication, and the cast steel wheel centres are provided with grease lubrication for the hub liners. On the wheel centres are shrunk 5in by 3in tyres turned to the particular contour adopted by the Peruvian Corporation.

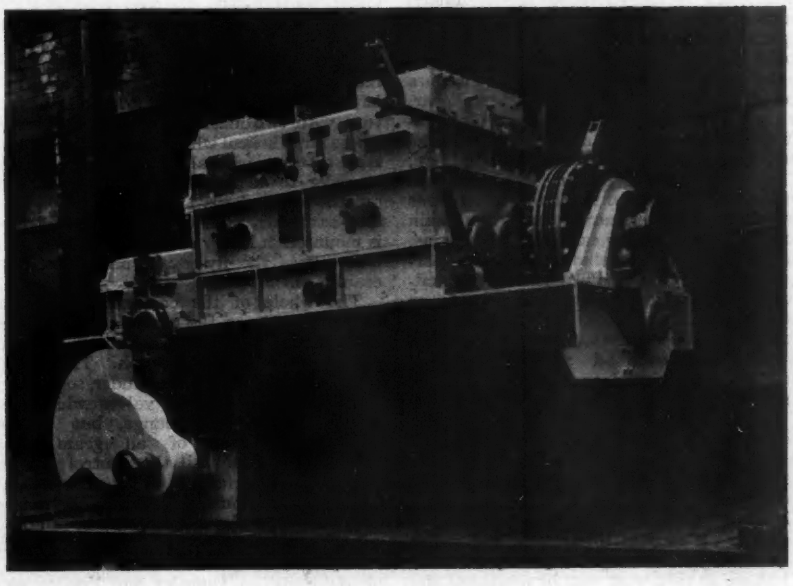
The frame structure is built up of 1¼in steel plates tied by heavy buffer beams at each end, and by a comprehensive arrangement of horizontal and vertical stretchers, one of which is formed by the lower half of the welded steel gearbox, which acts as a very rigid cross member some 7ft long. Above the running plate level a long sheet steel casing houses the engine and main transmission shafting, and at the front a separate compartment houses the cooling fans and auxiliaries. Access is given to this front compartment through a door in the bulkhead ; the compressors and their drive can also be inspected through a cover on the front, below the grille. A very commodious cab has been designed to give the driver a clear view in each direction without leaving his swivel seat, and he can easily see both buffer beams. A swivel seat is fitted on each side of the cab and the duplicated controls in front of each include the main gear-changing, throttle, direction, braking and sanding handles. The engine exhaust is used for a hot-air system of cab heating.

Westinghouse straight air brakes apply blocks on all wheels through two 10in cylinders, providing a braking effort of 38 tons at 60 lb pressure and operating through fully compensated rigging. The hand brake is operated by a wheel against the front weatherboard of the cab. Sanding in forward and backward directions is effected by hand-operated levers. At present the freight stock on the Paita–Piura Railway is not equipped with continuous brakes but, as provision has been made for its fitting, Westinghouse automatic equipment will be installed at a later date on the locomotive.

The lower unit of the locomotive is a twelve-cylinder vee Paxman four-stroke, type "12 RPH" engine, with cylinders 7in by 7½in, a compression ratio of 17 to 1, a dry weight of about 7200 lb, and a top output of 500 b.h.p. at 1375 r.p.m. The characteristics and construction of this type of engine are well known. It has a cast iron crankcase structure,



500 H.P. DIESEL-MECHANICAL LOCOMOTIVE



LOCOMOTIVE GEARBOX

underslung main bearings secured additionally by horizontal tie rods, a drop forged crankshaft with main bearings composed of renewable steel shells with copper-lead linings, Y-alloy pistons, fork-and-blade connecting-rods, and cylinders and cylinder heads cast in units of three. At the back end of the crankshaft is fitted a Bibby coupling to take up torsional variations, and fixed on the casing of the coupling is the starting ring, the engine not being equipped with a flywheel. Water cooling is effected in two side radiators built up of Serck elements and Hunslet headers, oil-cooling units being provided above the radiator elements. A belt-driven fan draws air in through the grating at the front end of the locomotive and the air is expelled through side radiators by two further belt-driven fans. Through vee pulleys a drive from the front end of the engine shaft is taken to two compressors and to two centrifugal water circulating pumps. For electric starting purposes a 24V motor is used and a 24V, 550Ah battery housed in the cab is kept charged by a 1100W dynamo driven from the engine crankshaft. A welded steel fuel tank of 500 gallons capacity is mounted in the top of the casing.

From the Bibby coupling power is transmitted through a fluid coupling, flexible coupling and cardan shaft, and a self-ventilated friction clutch to a six-speed gearbox which incorporates a preselective mechanism box, and reverse gear. Final drive to the wheels is through a jackshaft, carried on roller bearings, and grease-lubricated side rods.

Following the maker's general practice, gear changes are made with internal gear clutches operated by air pressure. The reverse gear, which is between the change gear and the jackshaft, is also air operated, and the whole of the control gear is mounted in the top of the box, the box and control forming the complete unit shown in one of our illustrations. In this latest design of locomotive even the main clutch, which is normally carried on the engine, is mounted on the input shaft outside the gearbox, so that the complete transmission, including the whole of the control mechanism, forms one complete sub-assembly.

The self-ventilated friction main clutch takes 100 per cent overload above the engine torque, and is designed to start the heaviest trains from rest without difficulty. The makers can, if required, fit a hydraulic coupling on the engine flywheel without interfering in any way with the remainder of the transmission. In these clutches all mating parts are case hardened in order to reduce wear and sliding friction to a minimum. The open construction allows air cooling throughout the clutch and provides a means of easy inspection of the linings, so that wear can be measured and checked at regular intervals, and ample warning is given when relining is necessary. This clutch is designed to accommodate the full engine power at starting and can maintain full torque under maximum slipping conditions as long as is needed on any railway job without overheating. It is designed for use without any other slipping medium.

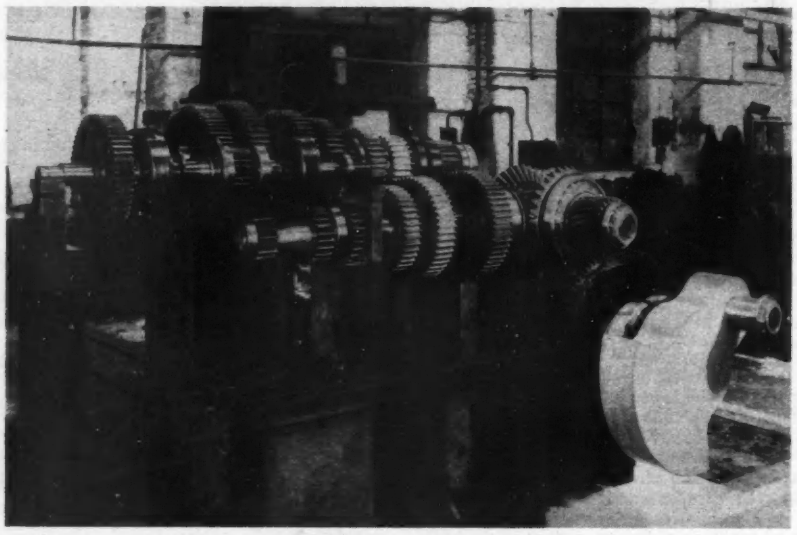
The gearbox, which is sectionalised and split on every centre line, is a complete stress-relieved welded structure. Stripping and assembling is a straightforward job and all shafts and wheels can be lifted from the box as assembled items without any internal stripping being necessary. When the gearbox is in position in the locomotive, without dismantling the main part from the locomotive frame, the whole of the gear-change and reverse can be lifted out from above the frame and the jackshaft dropped out from below.

In order to avoid high peripheral tooth speeds in the gearbox an initial pair of wheels is fitted to reduce the gear-change shaft speed. The gear-change shaft carries six free-running wheels mounted on ball bearings to accommodate the six speeds, and these wheels are in constant mesh with six fixed wheels on the speed shaft. On the gear-change shaft three double-ended internal gear sliding clutches are used to clutch in any of the six speed wheels to the gear-change shaft. The bevel pinion on the speed shaft mates with two bevel wheels on the reverse shaft and a further internal gear sliding clutch on this shaft clutches either of the bevel wheels to the shaft to give forward or reverse gear.

On the extreme ends of the reverse shaft are mounted a pair of single helical pinions, one left-hand and the other right-hand, meshing in turn with two mating wheels on the jackshaft. These large helical wheels of 75-ton oil-hardened steel on the jackshaft are torsionally resilient in order to accommodate shock loading, and are the only wheels in the box which are not case-hardened. The 11in diameter jackshaft is mounted in heavy roller bearings and at each end carries the fly-cranks and case-hardened crankpins.

The whole of the compact power control unit in the top of the gearbox can be removed by taking off the top of the gearbox and turning it upside down on the bench. The unit comprises an operating air cylinder together with main and auxiliary air valves which control not only the gear change, but the complete pre-selection of all gears in the correct sequence. All the control details are adequately lubricated by means of splash from the box, and lubrication of the main gear drive is effected by a high-pressure pump.

Last week we took advantage of an opportunity to make a run with the new locomotive on the Stourton, Guiseley and Yeadon service, when it hauled a 570-ton train to Guiseley, whence, after shunting duties, it hauled a load of 270 tons to Yeadon. Throughout the trip the excellent performance of the engine with its heavy load on steep gradients was particularly noticeable especially on the section from Apperley Junction to Guiseley. On this section the gradient goes up at 1 in 60 for about 2 miles, followed by a short length at 1 in 53 and another at 1 in 62, and there are curves of 30 to 40 chains radius, some of them reverse. Throughout this section, which was covered in second gear, a steady speed of about 5 m.p.h. was maintained.



GEAR SHAFT ASSEMBLIES

Beilby Memorial Awards

FROM the interest on the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished work. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. The awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In general, awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original independent work of exceptional merit over a period of years.

The administrators are empowered to make more than one award in a given year if work of sufficient merit by several candidates is brought to their notice. In 1950 two awards, each of one hundred guineas, were made to Mr. W. A. Baker and Dr. G. Whittingham. Consideration will be given to the making of an award or awards from the fund early in 1952, and the administrators will therefore be glad to have their attention drawn to outstanding work of the nature indicated, not later than December 31, 1951. All communications on the subject should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30, Russell Square, London, W.C.1.

Technical Reports

Maximum Arc Energy Liberated During the First Current Loop in a Series A.C. Circuit. (*Ref. G/T254.*)—By H. Goldenberg, B.Sc., A.R.C.S. The British Electrical and Allied Industries Research Association, price 10s. 3d., post free.—The arc energy liberated during the first current loop is derived for a circuit consisting of an arc (of constant voltage characteristic), an inductance and a resistance connected in series across a sinusoidal voltage source of negligible impedance and of any given frequency. The maximum value of this arc energy for varying arc voltages is obtained mathematically for any point of start of current flow during a half cycle of the applied voltage wave (i.e., for any current asymmetry), and for any fixed values of inductance and resistance. Curves are drawn giving the calculated values of the maximum arc energy liberated during the first current loop for all current asymmetries for the cases of zero resistance and of a ratio of resistance to inductive reactance of 0·1. The relevant results of a previous paper by Boehne on this subject are obtained and extended in the present report by a more direct method, which permits further results to be computed with comparative ease, for one or more current loops.

Dielectric Relaxation in Dilute Solutions of Polar Molecules in a Non-Polar Liquid. (*Ref. L/T240.*) By S. Zienau. The British Electrical and Allied Industries Research Association. Price 4s. 9d., post free.—The relaxation behaviour of dilute solutions of polar molecules in non-polar liquids is usually discussed with the aid of the model proposed many years ago by Debye. In this report a generalised model with two competing relaxation processes is investigated in a preliminary way.

The Paris Machine Tool Exhibition

No. I

LAST year associations of machine tool manufacturers from Belgium, France, Germany, Italy and Sweden formed a European committee for the co-operation of machine tool industries with a view to promoting an interchange of scientific, technical and industrial information. As part of this scheme the committee—known as the Comité Européen de Co-operation des Industries de la Machine-Outil—decided to hold exhibitions of machine tools at regular intervals in the main industrial centres of Western Europe, each time in a different country. The first of these exhibitions was organised by the French manufacturers' association, the Syndicat de Constructeurs Français de Machines-Outils, and it was held at the Porte de Versailles, Paris, from September 1st to 10th last.

The exhibition occupied three large halls at Porte de Versailles and in it there was displayed the latest designs of machine tools and other equipment from a dozen countries. Although, as might be expected, manufacturers from France and Germany were by far the more numerous, a very high percentage of the machine tool-making firms in Belgium, Switzerland and Italy showed their products. In all about 800 firms exhibited and visitors from all parts of the world were able to obtain a good general impression of the trend of design and technical developments made in machine tools in recent years in a number of the major producing countries on the Continent. A number of visitors expressed some surprise and regret that very few firms from this country and the United States were represented. But it must be remembered that a large exhibition of machine tools now being organised will be held at Olympia next year, and under present conditions it is not easy for British firms to allocate time and plant for similar events overseas.

In arranging the stands the organisers attempted, with a fair measure of success, to group the various classes of machines so that visitors could examine and compare the design details of different makes with a minimum amount of trouble. This grouping was, of course, not complete, as many firms exhibited several kinds of machines, but it certainly did reduce to a great degree the necessity for searching amongst so many exhibits for a particular class of machine in which a visitor might be interested.

In one of the halls heavy and medium machines were exhibited, and in another lighter machines, welding and sheet metal plant. The third hall was used for the stands of makers of accessories, tools, testing equipment, power transmission equipment, heat-treatment plant, wood-working machines, &c. A number of heavy wood-working machines were exhibited in a separate outdoor section.

As might well be appreciated in an international exhibition of this kind, every kind and most sizes of production and precision tool-room machine was represented, and a majority were shown in operation. It was noticeable amongst the production machines, particularly the lathes, how the practice of working to direct dimensions and stops has been discarded in favour of copying with hydraulic and electronic gear from master units or templates, and checking by comparator methods. This practice combined with improved tool materials and design, and the use of greater power to make possible increased feeds and speeds, enabled many of the machines to give impressive performances to demonstrate the increased production figures that are now obtainable with modern examples of production plant.

As it would be impossible for us to give a fully comprehensive picture of the many machines exhibited, we have selected for brief description some of those which we think might be of general interest to our readers.

Together with representative examples of its large boring machines Schiess A.G., of Dusseldorf-Oberkassel, Germany, which is represented in this country by Alfred Herbert, Ltd., of Coventry, showed one of its single-column, vertical-turret lathes. This machine, illustrated in Fig. 1, is the smallest of three sizes and has a 39in table, the two other models having tables of 49in and 65in diameter respectively.

The main drive gearbox, motor and balance weights for the work heads are totally enclosed in the columns of the machine which is bolted to the base to form a single rigid unit. The drive to the gearbox is taken directly through vibration-absorbing flexible coupling from a vertical 40 h.p. motor. Final drive to the table is through helical gearing, and the sixteen table speeds from 6·2 to 310 r.p.m., which are available, are selected through a hydraulic control.

The cross rail, which has a vertical movement of 30in, is carried on large ways on the column, and is elevated through a 3 h.p. motor interlocked with an automatic rail clamping device. The cross rail head incorporates the saddle, swivel slide and turret slide with the turret. Through a worm and segment the swivel slide can be adjusted up to 45 deg. on each side of the vertical position. A balanced cast steel turret slide is carried in long square guide ways and has a travel of 28in in the swivel slide. The head is built with power feed and rapid traverse in the horizontal and vertical directions used at angular settings, there being available twelve feeds from 0·0039in to 0·39in per revolution of the table. The five-tool turret, which is fitted with an indexing and locking device, can be set for a maximum turning height of 43in above the table.

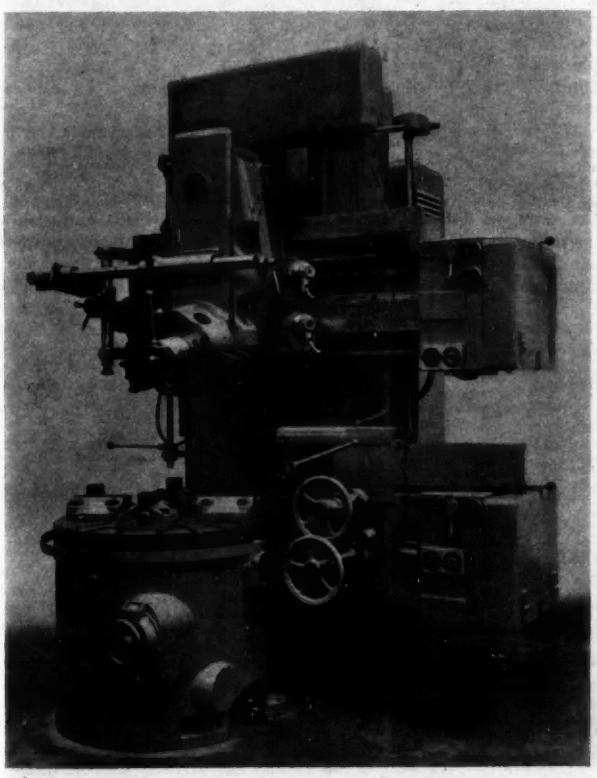


FIG. 1—VERTICAL TURRET LATHE

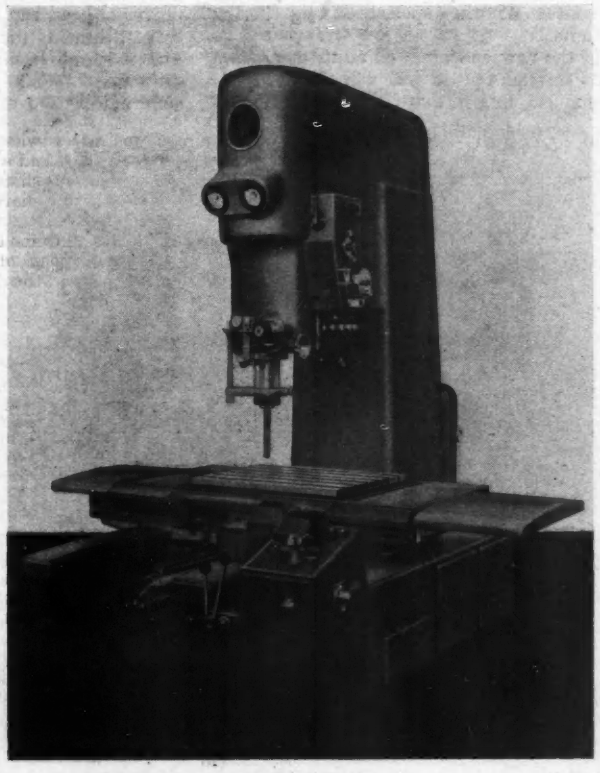


FIG. 2—CO-ORDINATE DRILLING MACHINE

A recent addition to the machine is a profiling attachment which can be seen at the left-hand end of the cross rail in our illustration. This attachment comprises a bar secured to the cross rail, a push-button control station, a thumb switch for selecting feed direction, a pilot lamp for indicating the engagement of the tracer control, and a control disc with stops in the feed box for controlling the automatic cycle.

Suitable interlocking devices are provided, so that during the profiling operation the wrong clutch cannot be engaged through accidental movement of the feed and rapid traverse controls.

In the cycle of operation when the "on" button is pressed, the tool approaches the work at a high speed. Then, through a cam on the control disc in the feed box, the rapid traverse is stopped, and the tool is fed vertically at slow speed close to the work. At the same time, the template is moved towards the tracer and, when it makes contact, the pre-adjusted horizontal basic feed is engaged. Profiling commences in the usual manner according to the impulses imparted by the tracer to the horizontal and vertical feed clutches.

If the "reverse" button is depressed during the profiling operation, the tool is returned to its starting position. In case of jamming an emergency contact in the tracer is opened, the entire system is cut off by means of the "stop" button. On completion of the profiling operation, the tool is returned at high speed to its starting position and disengaged.

The machine is fitted with a side head with a square tool turret, and this head has a travel of 22in with a power feed independent of the main head of the machine.

The machine we illustrate in Fig. 2 was recently developed in the works of the Apparatebau Burkhardt G.m.b.H., of Pfullingen, Württ, Germany, and is known by the makers as the "Hy-Op 51" co-ordinate drilling machine. It is particularly intended for high-speed precision production work to limits of plus or minus 0·01mm, as distinct from the very close tolerances of the specialised jig boring machine.

On the new machine all adjustments are made through optical gear without the use of mechanical intermediate numbers. Longitudinal and transverse table settings are projected, with 100 times magnification, on to ground glass screens adjacent to the operator's controls, and major movements can be checked on graduated bars in exposed positions.

The table, which has a working surface of 31½in by 25in, is hydraulically controlled, and its speed of movement is infinitely variable between ⅜in and 9½in per minute, with a rapid traverse of 13ft per minute. The spindle slide, which moves in large guides, is also hydraulically operated and has a travel of 9 1/16in, its speed of movement being infinitely variable between ⅜in and 9 1/16in per minute. The sleeve can be operated manually in the drill slide through a rack and pinion and drilling depth can be adjusted with the use of the measuring indicator and an end gauge or on a graduated ring. Large bearings carry the spindle in the slide and the spindle is driven through infinitely variable gearing at speeds from 100 to 1500 r.p.m.

It will be noted that all the controls for the table are conveniently grouped at one side of the machine and those for the drilling slide on the right-hand side of the head. The machine is particularly adapted for conversion to a vertical internal grinding machine, and for this purpose a grinding head driven by compressed air can be fitted on the spindle head.

The universal milling machines made by Etabl. P. Huré, of 218, rue Lafayette, Paris, in various sizes were shown arranged for a number of different classes of work. These machines, as can be seen in Fig. 3, are all fitted with a double swivelling head which allows the cutter spindle to be set at any required angle to suit the work in hand. By loosening a few bolts the main head can be turned on the column of the machine and the auxiliary head turned on the main head.

The machine we illustrate, model No. 73, is fitted with one of the recently introduced back-geared universal heads which is designed to give a range of eighteen spindle speeds from 20 to 1000 r.p.m. If required, the universal head can be removed and replaced by attachments for rack cutting or slotting. The machine has a table with a working surface of 1450mm by 310mm, with a power longitudinal feed of 850mm, transverse feed of 375mm and vertical feed of 470mm. The twenty-three table and saddle feeds range from 4mm to 640mm per minute, and the knee feeds from 2mm to 230mm per minute. With the spindle in its vertical position its axis is 340mm from the face of the column, and its nose has a maximum height of 525mm above the table. When the head is set with the spindle in its horizontal position, as shown in the photograph, its axis has a maximum height of 870mm above the table and a minimum height of 490mm.

These machines are handled in Great Britain by Sidney G. Jones, Ltd., of 8, Balham Hill, London, S.W.12.

An interesting optical profile grinding machine designed for operation by semi-skilled labour was demonstrated upon the stand of Hommelwerke G.m.b.H., of Mannheim, Germany. With this machine, which is shown in Fig. 4, grinding is done directly from a drawing of the contour required, and through its optical system there is available an infinite variation of magnification from 1 to 10 to 1 to 50 by setting with simple gauge blocks. Only one drawing is required for the production of similar profiles of different sizes.

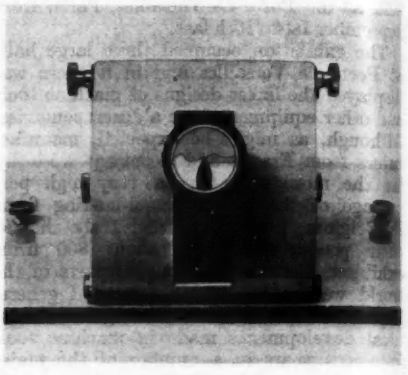


FIG. 5—SCREEN OF PROFILE GRINDING MACHINE

The machine consists of two major units, a magnification and control unit, and a grinding head unit. The drawing of the profile that it is required to produce is placed on the table of the magnification unit. This table is 15in by 17in, and above it is a projection unit in the screen of which the grinding wheel edge profile and part of the contour on the drawing can be clearly seen. The table is operated longitudinally and transversely by two handwheels below the screen. Through these handwheels the contours of the drawing are followed with the projected image of the edge of the grinding wheel, and the wheel itself on the adjoining unit reproduces the contour on the workpiece.

The table is connected to the wheel head

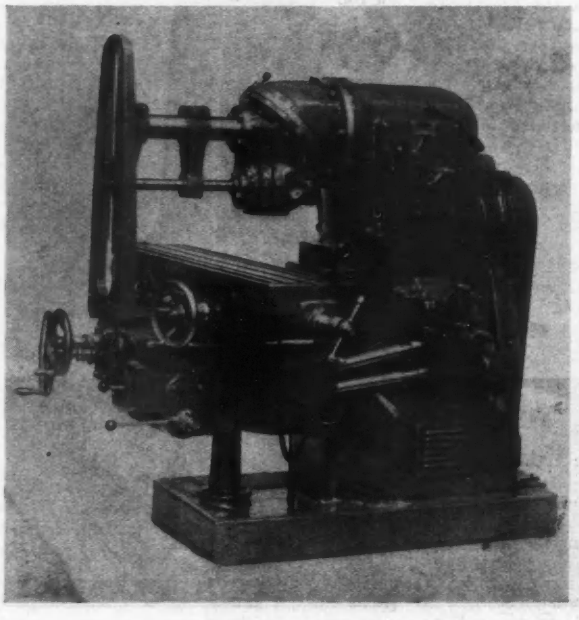


FIG. 3—UNIVERSAL MILLING MACHINE

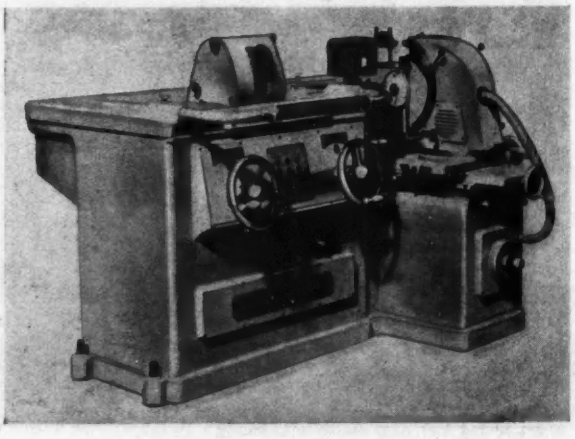


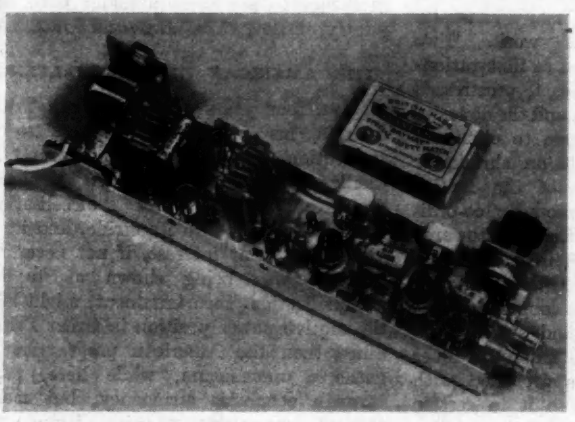
FIG. 4—PROFILE GRINDING MACHINE

through a system of levers and knife-edges, and whilst grinding is in progress the wheel is oscillated up and down through a hydraulic mechanism to impart a square edge and fine finish to the work. The work slide has an area 5⅝in by 7¾in and work up to 2¾in thick can be ground. For axial relief grinding, the head can be inclined up to 30 deg. and for side relief grinding inclined 10 deg. on either side. The photograph we reproduce in Fig. 5 shows clearly the image of the grinding wheel and the contour of the drawing projected on the workpiece as seen on the screen in front of the operator.

(To be continued)

Experimental Germanium Triode R.F. Receiver

To illustrate the capabilities and potentialities of the germanium triode, the General Electric Company, Ltd., Magnet House, Kingsway, W.C.2, has built a simple experimental radio receiver which gives acceptable loudspeaker output using germanium triodes instead of the usual thermionic valves. Like the early crystal detectors from which they are descended, germanium triodes consist essentially of a metallic crystal to which contact is made by means of points. The early crystal detectors were very unstable and erratic and have been completely superseded by the development of germanium crystal diodes for television receivers, modern crystal receivers and other technical applications. Experimental work in connection with these diodes has led to the development of the G.E.C. germanium triode, and it is now possible to design a radio receiver which is stable, capable of withstanding severe mechanical shock and, at the same time, able to produce loudspeaker output with a low power consumption.

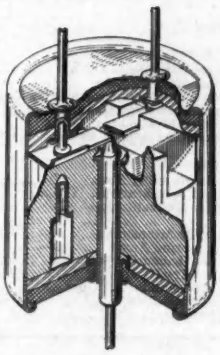


EXPERIMENTAL GERMANIUM TRIODE RECEIVER

Three points must, however, be borne in mind in connection with the present receiver: (1) it is only experimental and the industrial production of such a set is unlikely for some time; (2) although no filament heating power is required for the set, it is not independent of electrical supplies and it still needs an h.t. battery (or an equivalent mains unit, which may utilise germanium diodes as rectifiers); (3) the crystal triode is not likely to replace the existing thermionic valves of an ordinary radio receiver at present. Nevertheless, the germanium triode is an important development in the field of electronics, and it seems likely that the first application (besides lightweight radio sets) will include electronic computing machines which employ thousands of valves requiring substantial amounts of power for filament heating.

The experimental receiver (as illustrated) is of comparatively simple design and uses a two-circuit tuner to obtain reasonable selectivity. There are five G.E.C. germanium triodes in the r.f. amplifying, detector and push-pull a.f. output stages, which results in a receiver of sensitivity suitable for local station reception and an audio output of about 50 milliwatts. A more sensitive and selective receiver can, of course, be made by using more germanium triodes, for example, in a superheterodyne circuit, where a germanium triode oscillator would be employed.

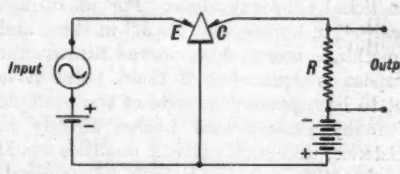
The total power consumption of the present receiver is about 10mA at 50V, from which it will be seen that about 10 per cent of the total power input is utilised as loudspeaker output.



GERMANIUM TRIODE

The germanium triode as outlined in our second illustration is of a form which can be manufactured relatively easily. It consists of two phosphor-bronze blades, 0·003in thick and 0·04in wide, supported in a moulded insulator. The gap between the blades is very critical and is obtained by a manufacturing technique which involves mounting a single strip across a channel in the moulding and subsequently shearing a gap a few thousandths of an inch wide with a specially designed cutter. The germanium is soldered to the tip of a metal stub and is ground to a point, with an angle of 60 deg. Then, by inserting the apex of the resulting cone into the gap between the blades, the essential two-point contact is made with the germanium and the spacing can be very accurately controlled. The three electrodes are then the two blades and the stub.

In simple terms, as shown in the accompanying circuit diagram, the electrical operation of the triode depends on the fact that if a negative potential is applied to one of the blades, the "collector" *C*, then the current to it can be varied by altering the positive voltage applied to the other blade, "emitter" *E*. The "emitter" draws appreciable current when positive voltages are applied to it, in contrast to the thermionic valve, in which it is the grid voltage that is the important factor controlling the anode current. In the germanium triode it is the "emitter" current that controls the "collector" current, i.e., it is a current-operated device rather than a voltage-operated.



GERMANIUM TRIODE AMPLIFIER CIRCUIT

The characteristics of the germanium triode result in a device of low input impedance (of the order of 500 ohms) and of relatively high output impedance (of the order of 30,000 ohms), and, of course, the associated circuits have to be designed with this in mind. For an amplifier a typical operating condition would be: collector, 1·5mA at −30V; emitter, 0·5mA at +¼V, and with proper impedance matching such an amplifier stage will give a power gain of 20–30 dB. Because of the limited safe collector current, the power output of a single germanium triode of the present design is about 20 milliwatts, for a tolerable degree of distortion. Oscillators, however, can be made with outputs up to about 100 milliwatts. There is an inherent upper frequency limit for operating the germanium triode, which arises from transit time effects in the germanium; at present this limit is about 10Mc/s.

Disembarkation Platforms at Holyhead Harbour

FOLLOWING the introduction, in 1949, of the two new motor vessels "Cambria" and "Hibernia" on the Irish Mail route between Holyhead and Dun Laoghaire, British Railways (London Midland Region) decided to install two electrically operated adjustable platforms at Holyhead for the disembarking passengers. The platforms are adjustable over a height range of 6ft 9in and provide a level gangway at any state of the tide. Each platform has a timber deck 10ft by 9ft 6in, which projects 4ft beyond the face of the Customs building, and twelve independent steps are provided to give access from the platform to the upper floor. These steps rest, when in the lowest position, on padstones in the enclosing walls. As the platform is moved up they are picked up in succession by the moving underframe and are arranged to form a level surface continuous with the deck. The steps are held in position by guides which run in small vertical channels recessed in the staircase walls.

The underframe of the platform was constructed of two 12in by 6in rolled steel beams 20ft 6in long, braced together 4ft apart and supported at their ends on four bronze nuts which operate on vertical square thread screws. These screws are carried on thrust bearings at their upper ends to ensure that they are always in tension under the weight of the platform. Each screw is supported between a pair of rolled steel channels which form the guides for maintaining the platform in position horizontally. The screws are rotated uniformly by an arrangement of bevel gears and shafts taking power through a single worm reduction unit coupled to a 5 h.p. electric motor, the whole of the operating gear being situated on foundations below the lowest level of the platform. An electro-mechanical brake is fitted to ensure that the driving gear is brought to rest and holds the platform in any desired position level with a step. Overrun in either direction is prevented by limit switches, the mechanism being controlled from the upper deck of the Customs House by push buttons. The platforms are positioned, before the arrival of the vessel, at a level to suit the average height of the tide during the disembarkation period, and are maintained in this position until all the passengers have landed.

RAPID MANUFACTURE AND DELIVERY OF TELEGRAPH WIRE.—We learn that British Insulated Callender's Cables, Ltd., has supplied 550 miles of bronze and cadmium-copper telegraph wire to Jamaica for restoration of the island's damaged telecommunication system. The order included 100 miles of bronze wire which was very urgently required; it was manufactured (from the casting, hot rolling and wire drawing to the inspection processes) and despatched by air within six days of receipt of the order.

THE ENGINEER

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THE BUILDING RESEARCH CONGRESS

THAT the building of houses is becoming more a concern for engineers is illustrated by the papers presented at the Building Research Congress which has just been held in London and concludes to-day. Of the eighty-eight papers presented, those in Parts II and III of Division I of the Congress, which are concerned with structural engineering and with soil mechanics, are, of course, primarily of interest to engineers. However, the remaining papers indicate clearly the extent to which engineering knowledge and techniques are being utilised in the design and construction of buildings. There are, for example, papers on building plant, prefabrication, acoustics, heating and air-conditioning, and so on. The second division, which is devoted to research on building materials, opens with a general paper in which the view is expressed that an extension of research, so that the manufacture of building materials would be brought within the scope of the chemical engineer as well as the chemist, is likely to be of more immediate benefit than almost any other field of materials research.

But how is all this research work, which is the subject of the congress, going to affect the normal, everyday, construction of houses? It is, of course, directed to securing increased efficiency at reduced cost. Many improvements have been introduced within recent years, particularly as the result of the work of the Building Research Station, and it is possible to indicate to some extent from recent progress, how these dual aims of increased efficiency and reduced cost may be achieved in the future. Houses, it may be, will be constructed largely of prefabricated, factory-made elements of standard sizes, thus reducing work on the site to a minimum. Their design will embody high functional standards, covering all the varied requirements of strength, durability and comfort. For instance, high standards of thermal and acoustic insulation, resistance to fire, structural strength, and intensities of artificial and natural light, will all be complied with. The durability of the materials forming the outside surfaces will be enhanced, so that maintenance work, such as painting, will be reduced to a minimum and faults such as damp walls avoided. Applications of soil mechanics will ensure the reliability of the foundations, particularly as the age of the house increases. We have already seen the beginnings of such advances and much recent research work springs to mind to exemplify it, as well as many examples of actual constructional work. Two examples may be mentioned as illustrations—the increasing use of precast, prestressed concrete floor and roof units, and the development of the short bored pile to eliminate settlements in houses built on shrinkable clays. The recent report of the British Standards Institution on modular co-ordination is also an important first step towards achieving a standardised system of units.

However, it should be noted that, although one or two papers before the congress discuss prefabrication techniques and standardisation, the subject of standardisation does not seem to have been approached with the thoroughness devoted to it in certain other industries. Probably that relative lack of enthusiasm for standardisation arises out of an appreciation that the functional efficiency of a house, as outlined in the previous paragraph, does not constitute the entirety of its design. The houses which are customarily regarded as fine examples are noted rather for their architectural quality—for an æsthetic "atmosphere," which is difficult to define—than for their functional efficiency alone. For we do not "exist" in houses, we "live" in them and something more than mere fitness for purpose is demanded of them. But it is not to be supposed, in spite of the example of many prefabricated houses already in existence, that such æsthetic qualities would be absent from a house built of standard, factory-made components. There are a number of examples to the contrary already to be seen in this country. Nor does the use of standard units necessarily mean the advent only of a few standard designs. A proper choice amidst the range of units and sizes that should become available would ensure that a high degree of flexibility of design, both for different houses of the same size, and for graduations in size, would be possible. There is a natural repugnance to changes in house-building methods that have, for centuries past, provided pleasant if not always very efficient houses. Yet, the history of architecture shows us that the advent of a new style can often be traced to the introduction of a new material or technique. Is it not possible, therefore, that new techniques in house-building now being developed will, in time, lead to the development of a new style in building? Moreover, is it not possible to foresee that certain other changes will have to take place? If it is to be true that house-building in the future will depend much more than in the past upon the development of engineering techniques, we still cannot suggest that the work of architects will no longer be necessary. Yet, under the circumstances, either the engineer will need to become in house-building, as he is already in the construction of dams and other more strictly engineering structures, the senior in the partnership; or, alternatively—and to our mind preferably—the professions of architect and engineer should merge. The papers presented before the congress indicate that engineers are now taking a deep and beneficent interest in architectural subjects, and if only to judge by the buildings in the South Bank Exhibition, architects are not now ashamed to draw upon engineering techniques. May it not become common in future to see upon a man's card, conjointly, the letters M.I.C.E. and F.R.I.B.A.?

THE AMERICAN DIESEL CHALLENGE

SOME four years ago Mr. Julian Tritton entitled his presidential address to the Institution of Locomotive Engineers "The Challenge to Steam." Then the great American programme of "dieselisation" was just getting into its stride, and at the same time great interest, if not necessarily concern, was being shown as to how nationalisation, then imminent, might affect the motive power position in Great Britain. Since then the American programme has gathered momentum, while here, partly through economic stringency, but mainly through its peculiar suitability to the intense, short-haul, though diverse, traffic of the British railways, the reciprocating steam locomotive is still held strongly in favour. For one reason or another trials of newer forms of motive power have not been noticeably successful here—so far at any rate; but while these first results may deepen the convictions of those who put their trust in steam, and gladden the hearts, to the extent of some unholy though surreptitious joy, of those who for none but sentimental reasons honour the same allegiance, there is, we feel, a far wider issue looming ahead than any question of motive power on the British railways. We do not doubt for one moment that the decision of the Railway Executive to concentrate upon steam power was overwhelmingly justified in present circumstances. However we may be threatened with recurring coal crises, the use of indigenous fuel, in preference to an imported one, is justified in these critical and uncertain days; and the solid reliability of the steam locomotive, its simplicity in handling, its versatility in

diverse conditions of service, and, above all, its low cost, certainly justify its continuance in present conditions.—On the other hand, it is important to appreciate just what "diesclisation" is meaning in the United States.

Statistics of individual railway motive power are striking enough. On several major railways in America the entire traffic is diesel-operated. By British standards these locomotive-studs are relatively small, and when it comes to the replacement of, say, 500 obsolescent steam locomotives by some 350 diesel-electrics the building programme does not seem so very different, in the number of units involved, from some of the replacement programmes carried out here, even in the difficult days since 1945. But, taking the matter of replacement still further, it comes as something of a shock to realise that on many American railways as much as 75 per cent of the entire locomotive stock is less than five years old. On the British railways we are inclined to cherish both the utility as well as the memory of famous old engines; earlier this year, for instance, in our own columns there was described a first-class performance by a Great Western locomotive thirty-seven years old. But in America, no less than here, the phenomenal change is not merely a matter for the railways themselves. In furnishing this new motive power a vast new industry has arisen, the productivity of which is exemplified by the milestone recently passed by the Electromotive Division of General Motors, in completing its ten thousandth diesel-electric locomotive. This achievement belongs almost entirely to the post-war years, and it is probable that more than 9000 units have been completed between 1945 and 1951. This is the output of one firm alone. The question naturally arises as to what will happen when the American home market is saturated. It is not likely that further replacements will be undertaken for some time by administrations that have incurred such heavy capital expenditure since the war; it is still less likely that the very enterprising manufacturers who have "sold" the diesel-electric locomotive with such success will be content to ease off production when the peak is reached, and exist upon a relative trickle of home orders.

Before very long the astonishing capacity of the American diesel locomotive building industry may become of vital concern to ourselves. It is thought that the peak demand, so far as the United States railways are concerned, will be passed in about five years time. Already American firms are making detailed surveys of railway operating conditions abroad, not excluding the countries of the British Commonwealth, with a view to producing standard designs suitable for quantity production at relatively low cost. As in the United States the aim is no doubt to build locomotives capable of running over the highest possible route mileage, and we can foresee "standard" units for the 3ft 6in, for the 4ft 8½in and for the 5ft 6in gauges becoming available in the near future. Such production capacity, backed by the experience of operation in the United States, constitutes both a challenge and a threat to our own locomotive building industry, with its great export market. While in steam locomotives the experience and resources of that industry can be regarded as second to none, it has not enjoyed the same opportunities for gaining experience in diesel locomotive operation as its American counterpart, and it is not likely to do so while the motive power policy of British Railways remains the same. We do feel, however, that, in view of the importance of our export trade in locomotives, some means should be sought of providing more facilities for experimental diesel locomotive running on sections of the British Railways.

Obituary

H. A. REVEIRS

THE ENGINEER has lost a faithful friend by the death of Mr. Harry Albert Reveirs, which occurred, in London, on Sunday last, September 16th, at the great age of eighty-six. From boyhood to age he had served the firm, founded by his father, which has printed this journal almost from its beginning. Harry Reveirs was the second son of the late George Reveirs, and, like his elder brother, was apprenticed in his father's works. He thus became familiar with the whole business of printing, and for the long span of seventy years or more made a worthy contribution to the work entailed in the weekly production of this paper. In recent years, failing health had severely restricted Harry Reveirs's activity, but to his end he retained his lively interest in the firm of which he was a part, and in its long association with us.

Literature

Danger Ahead—The Dramatic Story of Railway Signalling. By RICHARD BLYTHE. London: Newman Neame, Ltd. 1951., 29, Percy Street, W.1. Price 10s. 6d.

IT is an unhappy fact that much of the earlier development in the art of railway signalling came from the bitter experience of accidents. The best engineering brains in the railway world were at first concentrated upon building and maintaining the road and upon the provision of motive power. This was no more than natural, since in those days trains were infrequent and relatively slow and signalling had scarcely begun to emerge from a rough-and-ready means of maintaining a time interval between trains. To-day railway accidents by their very infrequency, always have an air of the dramatic and terrible about them and the sub-title of this present work suggests that the author had chosen to retell the stories of some earlier disasters as a background to his narrative. While playing the varied roles of broadcaster, journalist, actor and soldier in many parts of the world, Mr. Richard Blythe has remained a devoted railway amateur and his enthusiasm for many sides of railway work has led him, in this book, into many long and pleasant digressions from his avowed subject.

"Danger Ahead" is neither a connected narration nor a factual summary. It is an easygoing, rambling discourse, singularly mild, when it comes to references to such intensely dramatic events as the fearful runaway on the Armagh incline; but it is generally accurate in statements of fact. Chapters are devoted to the birth of railways, to the competition between the companies, though the treatment of signalling development itself is far from complete. There is not a mention of the Hawes Junction disaster on the Midland, on Christmas Eve, 1910, which gave such a spur to track-circuiting. There are, on the other hand, some interesting passages devoted to the development of railway telegraphy, particularly one noting that illiteracy among signalmen was one factor that hindered the rapid advance of signalling practice. The author has had the technical advice of Mr. D. S. Bennett, the managing director of Tyer and Co., Ltd., a firm whose hundredth anniversary falls this year.

If the author has somehow fallen short of his sub-title in his placid treatment of the subject, the illustrator, Dick Hart, has gone all-out for portrayal of the dramatic. In his sketches of accidents, however, he has achieved the macabre without being informative, though his drawings of early signals are excellent. The book is clearly the work of enthusiasts and providing one does not expect either a text-book or a thriller it can be well enjoyed.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE CLOSING OF BRANCH LINES

SIR,—I was most interested to read in to-day's issue of THE ENGINEER the letter from Mr. S. T. Saunders on the above subject.

I have often wondered why British Railways do not make use of diesel railcars, which are very much in evidence on the Continent. I recently made a journey from Venice to Rome and caught the 8.10 train from Venice, which is a diesel railcar train, averaging 60 m.p.h., and I arrived at Bologna at 10.10, enabling me to connect with the Milan-Rome air-conditioned "Rapide." This is a very good example of the use of railcars for connecting with main line trains. I would suggest that our officials of British Railways would do well to study the methods employed in Italy in this connection.

British Railways are quite naturally anxious to close unremunerative branch lines to save expense, but with an efficient railcar service it might be that these lines could be made to pay and carry very many more passengers than they do now. I have in mind a local branch line running from Maldon to Witham, where a considerable staff must be employed to run the few steam trains per day: with a diesel railcar more trains could be run with less staff.

PETER FRANCIS

Southend-on-Sea, September 7th.

BOOKS RECEIVED

Progress in Metal Physics. By Bruce Chalmers. London: Butterworth's Scientific Publications, Ltd., Bell Yard, Temple Bar, W.C.2. Price 45s.

Electric Power Stations, Volume II. Third edition. By T. H. Carr. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 75s.

Lubrication: Its Principles and Practice. By A. G. M. Michell. London: Blackie and Son, Ltd., 66, Chandos Place, W.C.2. Price 35s.

Displacement Pumps and Motors. By R. Hadekel. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 25s.

Plastics, Scientific and Technological. Third Edition. By H. R. Fleck. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 40s.

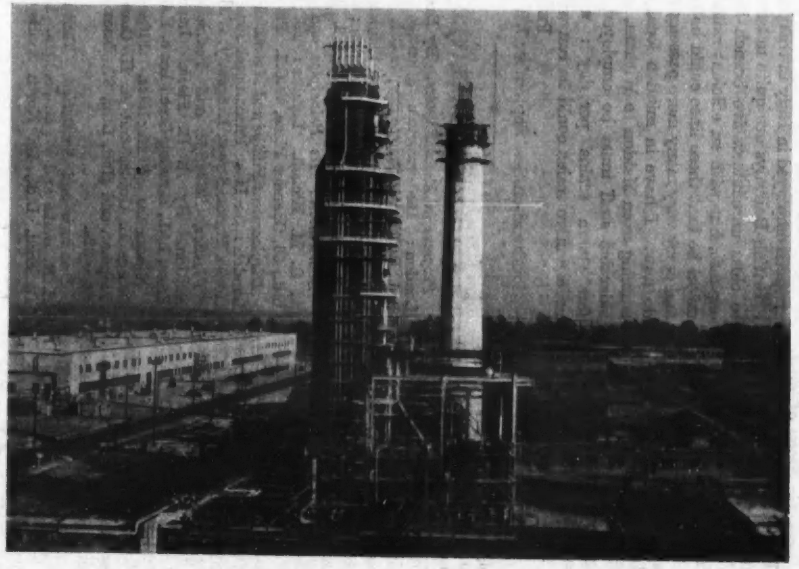
Kinematics of Machines. Fifth edition. By George L. Guillet and A. H. Church. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 32s.

Drainage and Sanitation. Tenth edition. By E. H. Blake and W. R. Jenkins. London: B. T. Batsford, Ltd., 15, North Audley Street, W.1. Price 15s.

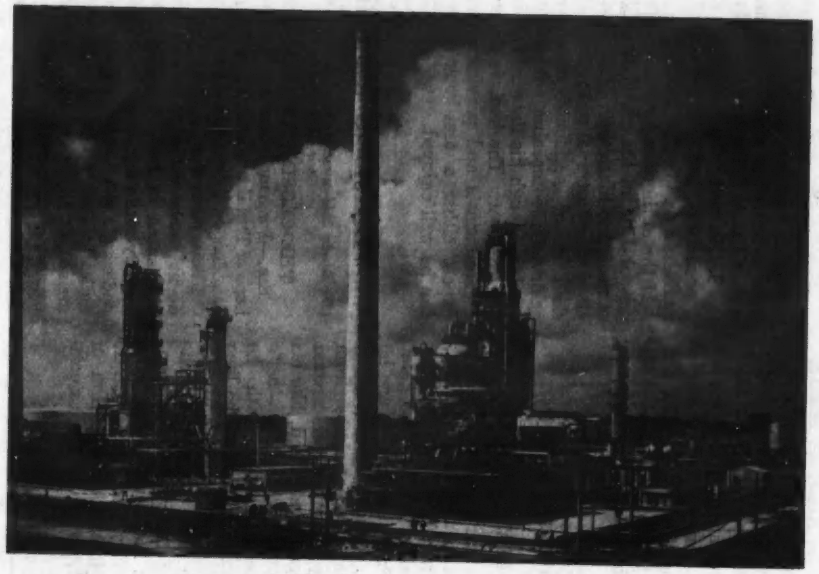
Technical Data on Fuel. Fifth edition. Edited by H. M. Spiers. London: The British National Committee, World Power Conference, 201, Grand Buildings, Trafalgar Square, W.C.2. Price 25s.

Chemical Analysis of Cast Iron and Foundry Materials. By W. Westwood and A. Mayer. London: George Allen and Unwin, Ltd., Ruskin House, 14, Museum Street, W.C.1. Price 42s.

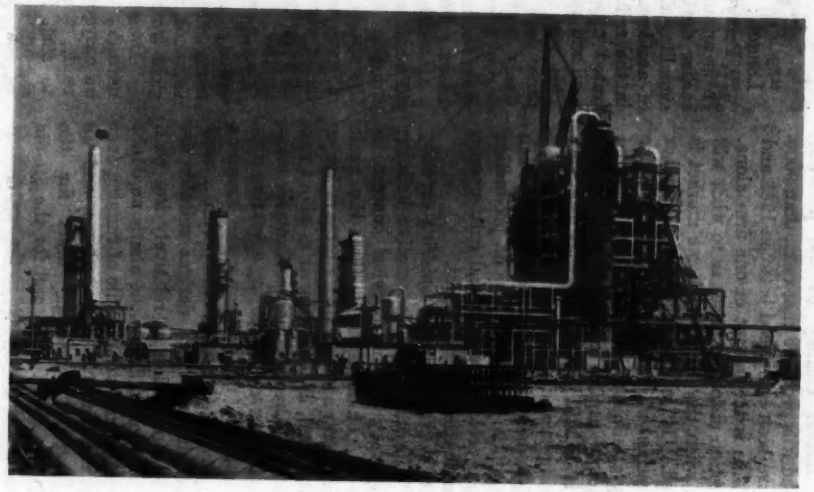
OIL REFINERY AT FAWLEY



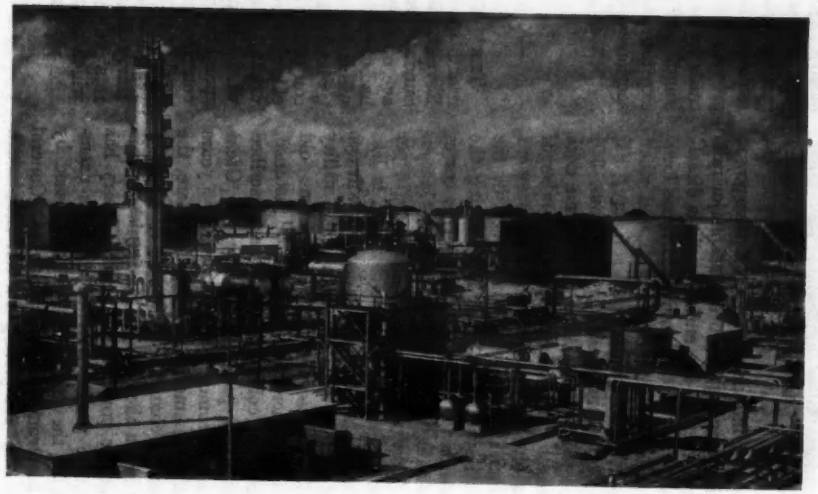
CRUDE DISTILLATION UNIT AND MAINTENANCE BUILDING



CRUDE DISTILLATION AND CATALYTIC CRACKING UNITS



GENERAL VIEW OF REFINERY UNITS



AUXILIARY UNITS AND TANK STORAGE

Oil Refinery at Fawley

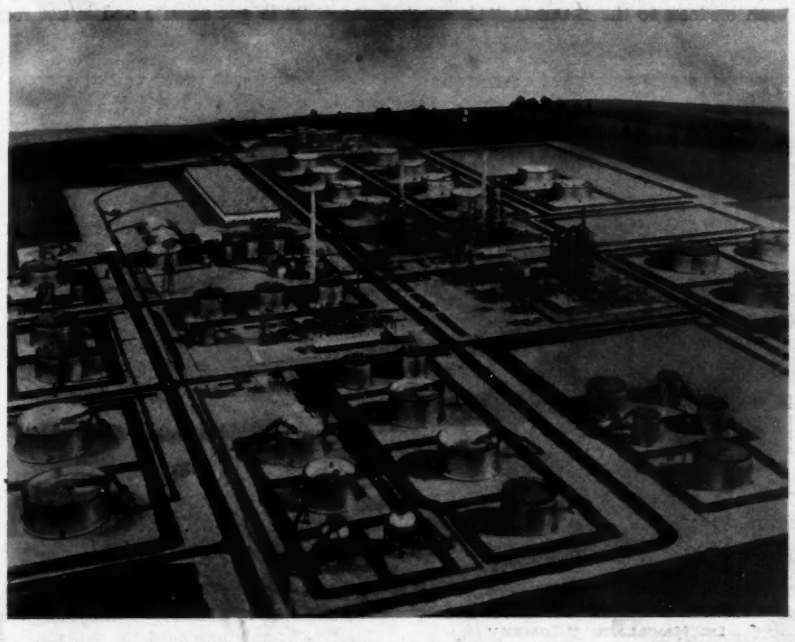
No. I

ON Friday last, September 14th, the new Fawley refinery of the Esso Petroleum Company, Ltd., was formally opened by the Prime Minister, the Right Honourable C. R. Attlee, C.H., who unveiled a silver commemorative plaque which will be placed ultimately in the entrance hall of the administrative building. Welcoming the Prime Minister, Mr. L. Sinclair, chairman of the Esso Petroleum Company, Ltd., said that the refinery was the result of British and American co-operation and represented a tangible expression of American faith in the future of Britain. Despite the demands of the rearmament programme, he continued, two-thirds of the equipment was of British origin, and the refinery's output of 5½ million gallons per day would satisfy one-third of the national requirements of petroleum products, and also result in a saving of 100 million dollars a year. Mr. Sinclair went on to say that an extension was projected for the production of sulphur from crude petroleum, and that thousands of trees had been planted around the refining area in an effort to preserve rural amenities. Mr. Frank W. Abrams, chairman of the Standard Oil Company (New Jersey), emphasised the value of international co-operation and the resulting benefits. Discussing the subject of investments, he said that while the people in the country whose resources provided the opportunity for investment had certain rights, the investor, who took risks in giving economic value to those resources, also deserved fair treatment. Mr. Abrams stressed the value of the private investor in international partnerships, saying that competition helped to accumulate knowledge, create new opportunities and benefit the consumer. The Prime Minister said that the Government had welcomed the project not only for the expansion of the production of oil products and the additional supplies of sulphur, but also for the valuable contribution towards the balance of payments by reducing the dollar cost. Referring to the loss of oil from Persia, Mr. Attlee stated that petrol supplies for 1951 were secure and that, by 1952, the development of alternative sources would more than compensate for the supplies normally brought from Abadan. The Prime Minister made it clear that we wished for an agreement with Persia, but warned that any long delay might cause loss of markets for Persian oil due to the expansion of other oilfields.

Selection of Site

The official opening ceremony of the new refinery at Fawley, marked the completion of twenty-seven months of concentrated effort. Now coming on stream, this refinery, the largest in Europe, will produce 6,500,000 tons of petroleum products annually, including 1,500,000 gallons of petrol per day, enough to satisfy one-third of Britain's requirements.

From pre-war days there has been a spectacular rise in the world consumption of oil and changes in the sources of supply, for America has become an importer of oil; thus Europe can no longer rely upon supplies from the United States and the Caribbean, but had to turn to the Middle East. As a result the production of oil from Kuwait, Saudi Arabia and Persia has rapidly expanded, as has also the need for increased refining capacity. During the post-war years, the serious shortage of hard currencies in Europe has made it imperative to restrict dollar imports. It has been a long-standing policy to refine oil at the source of production, but, to meet currency requirements, the oil companies reversed the old order and planned a new refinery building scheme which is playing, and will play, an increasingly important role in the post-war economic and industrial recovery by reducing the dollar content of oil products. The largest single project in the refinery development programme was the proposed new refinery for the Esso Petroleum Company, Ltd., which, when in full operation, will manufacture every major oil product except high octane fuel for aircraft. At Fawley, near Hythe, in Southampton Water, and opposite the Hamble River, a small refinery had been in existence for a number of years, and it was decided eventually to build the new refinery on an adjacent site. Several factors influenced the decision, the most important being sea communications, especially relation to the Middle East crude oil supplies and the pipe-line terminals at the eastern end of the Mediterranean. The extent of navigable water opposite the berthing jetty, and the unique double tide of Southampton Water, enables oil tankers to berth and unberth at almost any time during the twenty-four hours.



Model of Refinery

Following careful planning, work commenced in July, 1949, and the coming on stream of the refinery in September, 1951, has marked the completion of the whole complex scheme, costing £37,500,000, which included the clearing of the 450-acre site; the laying of a permanent railway track to link the refinery with the main line; the completion of a road system; the drilling of wells; the construction of the marine terminal and causeway; the erection of houses, workshops and the administrative building; the installation of a large steam plant and the construction of the crude oil distillation towers, catalytic cracker, and other refinery units, including pipe-lines and storage tanks. The whole of the work required some 100,000 tons of steel, 100,000 cubic yards of concrete, many miles of steel, cast iron and concrete pipes, enormous quantities of various grades of timber, and at a peak period employed a labour force of 5000 men. Our illustrations include a photograph of a model of the refinery, which indicates the disposition of storage and product tanks and the location of the main production units. Other photographs give general views of the refinery plant.

The nature of the land and its elevation was favourable for rapid and cheap development in preparation for the construction of the refinery, since the land consisted mainly of sand and gravel, and there was an easy gradient from the sea to a maximum height of 100ft above datum. The gravel proved suitable for concrete aggregate, and it was thus possible to meet the enormous demands for concrete for the foundations of the various refinery units. Furthermore, a nearby natural pond and an artesian well were able to supply the necessary water. A large concrete and aggregate plant, having an output of 140 cubic yards per hour, was erected at the spot and provided four grades of aggregate, while economical use of the water was ensured by arranging for the water, after it had been used for gravel washing, to flow through a series of settling tanks and thus remove foreign matter. Two concrete mixers of 3 cubic yards capacity were in continuous operation and, at approximately two minute intervals, were emptied into trucks which transported the concrete to the pouring point.

One ocean tanker jetty already existed at Fawley, but to supply the quantity of crude oil required for the new refinery it was essential to provide additional berthing facilities, and a new marine terminal, having a jetty 3200ft in length, and a 2000ft long approach over the salt marsh, from the end of the pipe-line road. The jetty was designed to accommodate four tankers having a maximum length between perpendiculars of approximately 700ft, and also provide a berth for one 250ft coaster. There is a safe anchorage in Cowes Roads about 5½ miles from Fawley, and the normal minimum depth of water in the navigable channel between the anchorage and Fawley is 36ft at low water ordinary spring tide. The ships are moored to four tee-shaped breasting islands, spaced about 800ft apart, each of which has two caissons 40ft in diameter, and have reinforced concrete shells filled with sand and situated one at each end. Each island is equipped with four heavy steel fenders having greenheart rubbing strips.

The jetty connects the breasting islands and incorporates three sand-filled caissons, 36ft in diameter, in each space between the islands, to assist in absorbing the horizontal forces set up when mooring the vessels. Two additional caissons are located at the northern and southern ends of the jetty, and are used as dolphins, and there is one caisson at the coaster berth. On the shore side of the jetty are situated the dockmaster's office, and a pump-house, which supplies the cooling water for the various refinery units. The causeway carries a number of steam and oil pipes and the salt water pipeline in two tiers and, in addition, there is a roadway for motor traffic.

(To be continued)

The S.B.A.C. Flying Display and Exhibition

No. II—(*Continued from page 343, September 14th*)

THERE were fewer civil aircraft participating in the flying display at Farnborough this year and these machines had been demonstrated at previous displays. It is pointed out, however, that the demands of security intrude also into the sphere of civil aircraft and certain technical developments, particularly those relating to propulsion, cannot be disclosed. Nevertheless, this country appears to have maintained its lead in the development of higher speed passenger aircraft, specifically designed to employ gas turbine propulsion and thus caused to fly in rarefied atmospheres, where the effects of low temperatures and pressures upon aircraft were once little known. Sir Miles Thomas, chairman of British Overseas Airways Corporation, has stated recently that he envisages within a few years the use of aircraft such as the "Comet" with pure jet engines, and the "Britannia 175," with turbo-propeller engines, on two round-the-world routes; one encircling the Northern Hemisphere and the other south of the Equator through Australasia. Sir Miles instanced the recent airbourne times of 15½ hours and 11 hours taken by the "Comet" aircraft to fly from London to Johannesburg and to Karachi respectively, and said that no two places on the earth were now more than thirty hours apart. Sir Miles mentioned also that the Corporation planned to cater not only for first-class express services but to bring the benefits of world-wide air travel within the reach of a still larger section of the community by introducing tourist rates.

DE HAVILLAND "COMET"

Civil Aircraft

The "Comet" made by the de Havilland Aircraft Company, Ltd., remains the only pure jet commercial airliner in this country and although followed closely by the Avro Canada "Jet Liner" was the first of its kind to fly. The "Comet" Series I machine has four de Havilland "Ghost" centrifugal jet turbines, each developing 5000 lb thrust at 10,250 r.p.m., sea level, the compressor and turbine being single-stage units. It is a medium-range airliner, seating thirty-six to forty-eight passengers, with stage lengths from 1000–2000 miles, with due fuel allowances made for head wind diversion and stand-off. The cruising altitude varies from 35,000ft to 42,000ft at which heights it can cruise with an air speed of 490 m.p.h.

The "Comet" has now reached the operational stage of its development. The first deliveries of B.O.A.C.'s initial order for fourteen "Comets" will be made during the closing months of this year and the Corporation hopes to introduce the aircraft on regular services along its Commonwealth routes early in 1952. Since April 2nd, the second of four prototypes now flying has been on loan to the B.O.A.C. "Comet" unit. Based at London Airport, this aircraft has been engaged on route-proving trials and during the course of ten overseas tours to date, the aircraft has flown some 75,000 miles. A noteworthy flight was that to South Africa on July 18th last, when the "Comet" flew the 6200 miles to Johannesburg in 17¼ hours, including halts at Cairo and Entebbe. The average airborne speed was 422 m.p.h.

Work is well advanced on the prototype Series 2 "Comet," which will be fitted with Rolls-Royce "Avon" engines. This is a long-range version intended for operation along the more severe world routes, with stage lengths up to 2500 miles. It will first see service with B.O.A.C., who will have five Series 2 "Comets" amongst its initial order for fourteen aircraft. The Series 1 "Comet" is now ready to enter air-line service and should prove to be outstandingly economical on stage lengths of between 1000 and 1750 miles. The "Comet" first flew in July, 1949.

A paper describing in detail the production methods used on the "Comet" aircraft was read before the Royal Aeronautical Society on April 12, 1951. Although this aircraft did not give a flying demonstration this year, visitors were able to inspect its interior arrangement.

The propeller turbine airliners at their present stage of development, operate with a specific fuel consumption, at speeds and in most cases at heights between those of the piston-engined machines and the pure jet aircraft. Three of these aircraft were demonstrated again this year and were led by the Vickers "Viscount 700," which is the first turbine-engined civil aircraft to receive a certificate of airworthiness. This machine is fitted with four Rolls-Royce "Dart" R.DA.3 centrifugal-flow gas turbines, each developing at sea level 1400 b.h.p. and 365 lb thrust at 14,500 r.p.m. The "Viscount" is in production for British European Airways and other major air-lines and it will be known as the B.E.A. "Discovery" class airliner when it enters service in 1953. An earlier mark, known as the "Viscount 630," has already been used to carry fare-paying passengers on scheduled B.E.A. flights. The machine is designed to cruise at 275 knots, at an altitude of 25,000ft, maintaining at this height cabin pressure conditions equivalent to a height of 5000ft. Conditioned air is supplied at a rate of 72 lb per minute and is not recirculated. The "Viscount" is the first aircraft to embody a thermal de-icing system which does not rely on combustion heaters. Air is passed through heat exchangers in each inboard nacelle and ducted to the leading edges of both mainplanes, both tailplanes and the fin. This method banishes the fire risk attendant upon combustion heaters and ensures a non-corrosive flow of hot air. The propellers are electrically de-iced.

There are two models in the "700" series, arranged either to seat forty or fifty-three passengers, and each provides catering and toilet facilities. The aircraft has a still-air range of 1950 miles. As part of its demonstration, the "Viscount" was flown with both engines on one side feathered and, under these thrust conditions, it is said to be easily handled without re-trimming.

The largest turbo-propeller airliner now flying is the Handley Page "Hermes" V, of which there are two prototypes. Both machines have the Bristol "Theseus" turbine but, as the company state that this engine is not going into full-scale production, future "Hermes" aircraft are to be fitted with four of the larger Bristol "Proteus" gas turbines. In both these installations the propeller is geared with a "free" tur-

bine. At sea level the "Proteus" develops 3200 b.h.p. and 800 lb thrust at 10,000 r.p.m., and it is now scheduled to power the "Princess" flying-boat, the Bristol "Brabazon" Mk. II, and the "Britannia 175," also under construction by the Bristol Aeroplane Company, Ltd. With the "Proteus" engine the "Hermes," series Vb, will have a slightly increased wing span, owing to the need for larger diameter propellers.

"Hermes" Vbs, with four "Proteus" turbo-propeller engines, will take off in 1360 yards at a weight of 100,000 lb in an I.C.A.N.+15 deg. Cent. atmosphere.

Range/pay load characteristics will show a marked improvement in comparison with the "Theseus"-powered version. With a pay load of 13,900 lb, the still-air range is expected to be 3000 miles at 390 m.p.h.

An example of typical air-line operation of the "Hermes" Vb is a stage route of 1500 miles, against a headwind of 60 m.p.h. cruising at 370 m.p.h. and allowing fuel for a two-hour stand-off, engine mal-adjustment, airframe deterioration, navigational errors, fleet variability, &c., the maximum pay load amounts to 17,000 lb and a block-to-block speed of 302 m.p.h. is achieved. With 231 lb taken as the standard weight of a passenger and luggage, the "Hermes" Vb would fly such a stage-length with sixty passengers and a freight load of over 3000 lb in its pressurised holds.

The Mark V series are fitted with Handley Page double-slotted flaps, which considerably enhance take-off, landing and slow-flying characteristics.

Handley Page (Reading), Ltd., exhibited in the static park the Miles "Marathon" I high-wing, 18/22 passenger feeder line transport aircraft, which it is producing for service on British European Airways' routes next year. The Mark I version has four de Havilland "Gypsy Queen 70" supercharged piston engines, each developing 340 b.h.p. Its best range speed is 157 m.p.h. and its range over 1000 miles. With a maximum all-up weight of 18,000 lb, it requires only 920 yards distance to attain 50ft and from that height less than 800 yards distance to stop. It is capable of flight at maximum weight with both engines on one side inoperative. The aircraft is fitted with a retractable tricycle undercarriage. Development continues with the "Marathon" II aircraft, which has two Armstrong Siddeley "Mamba" propeller gas turbines, instead of the original piston engines. This machine is now fitted with propellers capable of negative thrust for braking purposes, and was entered and demonstrated by de Havilland Propellers, Ltd., who have developed this installation. It is pointed out by this company* that a "fixed pitch" propeller braking system, as fitted to piston-engine aircraft, can be used with a gas turbine having a "free" power turbine without modification. In this case the engine is not sensitive to propeller pitch either when running or on starting as the propeller is virtually gas-coupled to the engine and could be started with the propeller locked mechanically or in feathered pitch. The characteristics, however, of a gas turbine with the power turbine and the compressor mounted on a solid shaft, as is the usual arrangement, make the design of a propeller braking system much more complex and the present installation is stated to be the first known to have undergone flight trials successfully.

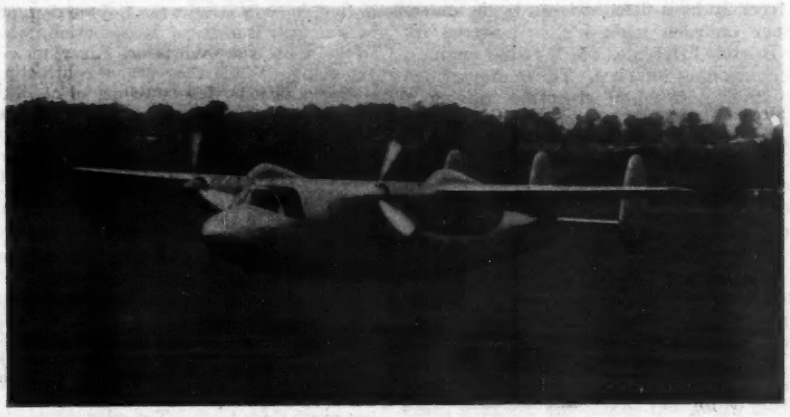
*"Negative Thrust Propellers for Turbines," by H. R. Leather and P. Brett. de Havilland Propellers, Ltd.

The effectiveness of this installation was clearly demonstrated at Farnborough and the landing run of this aircraft is said to be halved. A comparison of these two versions shows that although the maximum all-up weight of the gas turbine machine remains unaltered at 18,000 lb and that the fuel capacity must be raised by 46 per cent, to allow a comparable range, its maximum pay load can be increased by 23 per cent and the mean cruising speed by 22 per cent.

The Armstrong Whitworth "Apollo" civil aircraft was not shown this year. The prototype now flying has four "Mamba" axial flow gas turbines, which have an outside diameter of only 29in. With gas turbine propulsion, an advantage derived from a propeller turbine installation is the ability to maintain reasonable propulsion efficiency under conditions distant from the optimum cruising speeds and heights. This characteristic is particularly desirable when an aircraft is obliged to fly with one or more of its engines inoperative or unserviceable. At previous displays the "Apollo" has demonstrated flight with only one engine operative and the company state that it could maintain height with load at low levels on a single engine.

The Bristol Aeroplane Company, Ltd., had again despatched the "Brabazon" to the

THE VICKERS "VISCOUNT"



HANDLEY PAGE "MARATHON" II WITH BRAKING PROPELLER GAS TURBINES

display, but this year it was only to dominate the static aircraft park, where visitors were allowed to inspect the interior. It will be recalled that the "Brabazon" gave a series of flights to non-fare-paying passengers in July from London Airport and we reported upon that machine up to that date. Apart from a relatively small and improvised passenger saloon, most of the interior is occupied with flight research equipment. A modified undercarriage is shortly to be fitted, which will have on each main leg four twin-tyred wheels of reduced diameter instead of two as at present used. This will be an unretractable version of the landing gear to be used by the "Brabazon" Mk. II. The use of the Mk. I version in the immediate future will be principally for development of various special features, to be incorporated in the turbine-engined Mk II, construction of which is now well advanced.

Apart from slightly increased dihedral on the outer wing sections, the Mk. II aircraft is a basically similar machine, but is fitted with eight Bristol "Proteus" turbo-propeller engines. These engines are mounted in coupled pairs and as with the "Centaurus" units in the Mk. I machine are installed within the wing profile. The manner in which they combine, however, is essentially different in that they are coupled together to drive counter-rotating propellers, whereas with the "Centaurus" arrangement each engine of a pair drove through dual reduction gears its own propeller, these propellers being coaxial. The aircraft is designed to cruise at 350 m.p.h. at 35,000ft, with a fuel consumption of 0·512 lb/e.s.h.p./hour. At take-off the machine develops 28,060 e.s.h.p. The controls differ also in that the Mk. I machine has hydraulic power-operated control units, using only temporary mass balances (now removed), whereas the controls of the Mk. II aircraft are to be manually operated with aerodynamic balances and servos.

Freight Transports

The largest freight aircraft in this country is the "Gal. 60" military transport, which is made by the Blackburn and General Aircraft, Ltd. This first prototype, which has recently been fitted with a bogie undercarriage on each main leg, is powered by four Bristol "Hercules 261" radial engines, each developing 2000 h.p. The undercarriage is a fixed, nose wheel structure having a steerable twin-wheeled front unit and four-wheeled bogie main units with hydraulic disc brakes fitted to all eight main wheels. It is intended that the differential brakes on the main wheels will be used for steering during take-off and landing, whilst the nose wheel steering will be used for taxi-ing when the flying controls may be locked.

This machine is similar to the civil version known as the "Universal" freighter. The Mk. II version of the aircraft is to have the more powerful Bristol "Centaurus 171" engines, which will enable the designed gross weight to be raised from 105,000 lb to 127,000 lb. This version will also have a modified rear fuselage consisting of a tubular tail boom above the freight compartment. It will have a wing loading of 43½ lb per square foot, compared with the very moderate loading of 36 lb per square foot of the Mk I. On certain ranges the pay load Mk I can be as high as 15 tons and it can accommodate buses or heavy lorries, bulldozers, guns or light tanks.

The wing span is 162ft and the length 98ft 4in, the maximum speed being 225 m.p.h. The demonstration of its landing, take-off and slow flying characteristics, for a machine of this size, were most impressive, and the landing data given for the Mk II machine show a ground run of only 230 yards with maximum landing weight when using the wheel brakes and braking propellers.

Another freighter which has acquired a sound reputation is the Bristol "Freighter" type "170," Mk 31, and it was this year exhibited only in the static park.

This type has been operating in many parts of the world since 1946. It is a high-wing aircraft, with a span of 108ft, length 68ft, and is powered by two "Hercules 734" radial engines, each developing 2040 b.h.p. Its design was aimed to reduce maintenance requirements to an absolute minimum in order that it might serve in areas where skilled labour was not available and partly for this reason it has a fixed and robust undercarriage. The machine is now operated quite extensively in remote regions of Australia and New Zealand, using the crudest landing strips, and its distance to attain a height of 50ft is as low as 770 yards. The machine has a spacious hold and is accessible by nose ramp. One recent load was the assembled fuselage of a helicopter, 42ft long. In Australia twenty stud bulls were transported in a single consignment. In this country Silver City Airways operating a cross-Channel service with six freighters had by August this year carried 6720 cars and 4380 motor-cycles and bicycles. The "turn round" serviceability of this type of machine can be realised by other figures, which disclose that on one particular day each of these machines made seven round trips.

One typical range of the type "170" is given as 400 miles with a pay load of 12,500 lb, the cruising speed being 166 m.p.h. at 5000ft. It has a maximum speed of 200 m.p.h. at 10,750ft.

(To be continued)

Tree Clearing Operation at Boysen Dam Reservoir

The accompanying engraving shows an interesting tool which was developed by the contractors engaged in the clearing of trees in the reservoir area at the Boysen dam project of the U.S. Bureau of Reclamation, which is situated on the Big Horn River in central Wyoming. While the various contractors use slight variations, the basic model of the bulldozer saw consists of a heavy rigid steel frame, built in a V-shape, with a heavy shoe which is bolted to the bulldozer. The upper part of the frame is either bolted directly to the frame, or is fastened to a special welded connection. At the base of the saw frame there are blades, 6ft long, on both sides, usually made of 0·40 to 0·50 per cent carbon steel, with large saw-like teeth welded on. As a general rule, the saw blades are at least ¼in thick for use in conjunction with such tractors as the Caterpillar "D 7." A slightly different version of the tool is known as a "willow cutter"; it has a wider V-angle and is built on a frame similar to a snow plough. Its bottom cutting edge has much finer teeth. The advantages of both machines include greater clearing speed, lower clearing cost per acre, and a tendency to cut the trees down flush with the ground. The stumps are, therefore, entirely eliminated.

Most of the seven contractors engaged at Boysen reservoir use similar clearing methods. The tractor operator selects a large area and starts his work on the outside perimeter. The machine lowers its blade so that the saw is flush with the ground, eases up to the tree, and as the tractor moves ahead in first gear, the operator feeds the saw into the tree with the aid of the port steering clutch. The saw cuts through the base of the tree and, as it begins to topple, the operator guides its fall with the bulldozer blade. The aim is to make the tree fall out at right angles to the standing area, leaving the felled timber laid out neatly. The skill and conscientiousness of the operator seem to play a big part in this operation, Severe twisting forces are applied to the saw frame even under good conditions, so that the operator has to be sufficiently skilful to make a straight, clean cut without placing the blade in a twist. The saw appears to work best when the operators use first gear. If used correctly, the saw blades last a month without losing

Bulldozer-Mounted Saw

teeth. A single machine is capable of clearing 5 acres of dense timber in an eight-hour shift, and it has been estimated that each of the saw-equipped bulldozers clears more trees than could be felled by five chain-saw gangs. The clearing project at Boysen dam reservoir involves 12,700 acres, of which 3600 is classified as heavy timber. The machine has proved its ability to saw through trees up to 24in in diameter with only one stroke. It was introduced by the Mid-States Construction Company, of Chisholm, Minnesota.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

METHODS FOR SAMPLING AND TESTING OF MINERAL AGGREGATES, SANDS AND FILLERS

No. 812 : 1951.—This standard is a complete revision of the 1943 edition and is intended to bring up to date and to co-ordinate more clearly the test methods for the various uses of aggregates, sands and fillers. In the section dealing with particle size analysis, methods of sieving are specified in greater detail, separate requirements being given for coarse, fine and all-in aggregates and for fillers. A new section is added to give rock and mineral names in very great detail. Price 6s.

GLOSSARY OF TERMS USED IN THE PLASTICS INDUSTRY

No. 1755 : 1951. This is one of the documents in the series which is being prepared to cover glossaries of terms used in various industries, and it is hoped that it will provide for greater uniformity and precision in the use of terms.

It is of considerable importance at this juncture as it will form a basis for discussions on an international level by Technical Committee 61—Plastics of the International Organisation for Standardisation. The terms are grouped in sections to cover chemistry, industrial applications, constituents, properties, moulding processes, and other manufacturing processes. The terms listed in the various sections are fully defined. Price 6s.

Engineering Aspects of the New Town of Crawley

READERS of THE ENGINEER will no doubt be familiar with the basic ideas of town and country planning, which have been applied to the various projects for new towns now in the course of construction. Eight of the new towns which have so far been started are intended to check the growth of Greater London and eventually to promote a decentralisation of London's population and industry. Their construction was authorised by the New Towns Act of 1946, which embodied principles of construction recommended in the Reith report and in such reports as that of the Barlow Committee on the location of industry and the Abercrombie plan. Stated very briefly, the aim was to construct towns which would be self-supporting and would provide in good measure all those varied facilities and amenities which would enable their inhabitants to enjoy a full life in pleasing surroundings. Although such problems may be regarded as to some extent sociological and architectural in their nature, there is a considerable interest in the basic engineering services of the new towns, upon which the other factors depend. The opportunity of being able to plan and install such services comprehensively for an entire town in contrast to the inevitable piecemeal growth in our established towns and cities, adds considerably to the interest of the work. It is proposed therefore to describe in the succeeding paragraphs the engineering aspects of the new town of Crawley in Sussex, one of the more advanced of the eight satellites of Greater London, and one which has a number of interesting points in the design of its engineering services.

Crawley New Town is situated in the Weald, about halfway between Brighton and London, on the trunk road A23, which connects those two towns. It is intended for a population of 50,000 to 60,000 and incorporates the old town of Crawley and the village of Three Bridges, the existing population being about 10,000. The accompanying illustration shows the general lay-out of the new town and the existing buildings. It may be observed that the main Southern Region railway line from London to Brighton passes along the east of the designated area, which covers about 6000 acres, being about 4 miles from north to south and 3 miles from east to west. To the north lies Gatwick Airport; the Mid-Sussex railway and the trunk road A23, both pass through the area. These existing developments were such that the most suitable lay-out for the new town was a ring and radial pattern, as is shown in the illustration referred to above. Thus there are nine residential "neighbourhoods," each containing dwellings for 4000 to 5000 people, some shops and a primary school. The main ring and radial roads pass between the neighbourhoods; A23, it may be observed, forms part of the ring road. There is then a town centre, incorporating the old town and new shops and civic buildings, three "campuses," each including secondary schools, a health centre and recreational buildings, and various other amenities such as parks and a hospital, as indicated in the diagram. To the north lies the industrial area. Construction of the new town was started at the end of 1948.

WATER SUPPLY

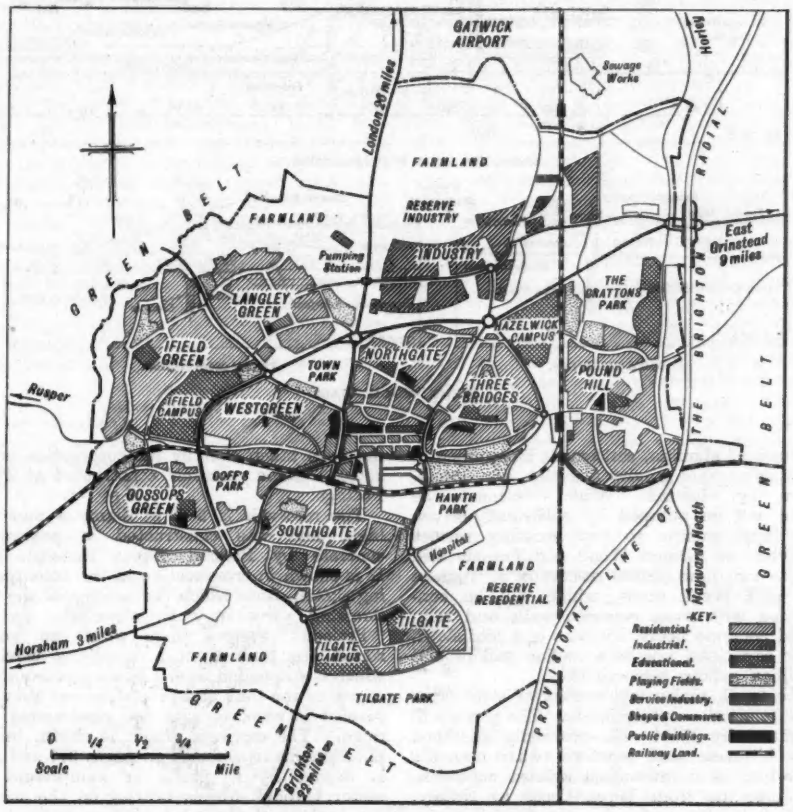
An extensive water supply scheme is being constructed to supply the new town and various neighbouring rural districts. In the past Sussex has relied largely on underground sources of water, but the increasing demand over the years has meant that many water authorities are in need of augmented sources of supply. A survey of Sussex water supplies carried out by the Ministry of Health in 1944 disclosed that underground sources of water were already being pumped in excess of capacity and that yields from wells were falling off. The consulting engineers, Messrs. Herbert Lapworth and Partners, who had advised water authorities in Surrey and Sussex for many years and who were later appointed consultants on water supplies for the new town, supported the Ministry of Health's views and recommended the examination of two alternative new sources of supply, an impounding scheme in East Sussex and an intake scheme in West Sussex, the first of which was eventually adopted.

Before the project for the new town was started the existing population was being supplied with about 0·25 m.g.d. by four water authorities—the North West Sussex Joint Water Board, Cuckfield Rural District Council, the East Surrey Water Company and the Mid-Sussex Joint Water Board. None of these authorities possessed sources of water from which the requirements of the new town could be met, so the opportunity was taken of setting up a single supply board under the Water Act of 1945, the Weir Wood Water Board, to enable joint development of the water supply of the area. The constituent bodies forming the Board were the Crawley Development Corporation for the area of the new town, and the South Eastern Gas Board, the Cuckfield R.D.C., and the Uckfield R.D.C., for other areas in East Sussex.

The requirements of the new town of Crawley were estimated at 3·25 m.g.d., consisting of a domestic consumption based on a figure of 45 gallons per head per day for 50,000 persons (2·25 m.g.d.) and an industrial consumption of 1 m.g.d., based on a rate of 80 gallons per head per day for the 12,000 persons employed in industry. The total yield from the completed projects of the Board will be 5¼ m.g.d., and 2¼ m.g.d. will be required by the other authorities represented on the Board, the whole scheme thus serving a large area of East Sussex.

The scheme involves damming the head waters of the Medway at Forest Row, 8 miles from Crawley, to form the Weir Wood reservoir. The construction of an earth dam was envisaged to form the reservoir which would provide a storage capacity equal to nine months' consumption, to even out the summer and winter flow of the rivers. Water from the reservoir would be treated and pumped to service reservoirs in the areas of supply.

The Medway reservoir at Weir Wood is at present being constructed. It will have a flooded area of 350 acres and will be supplied by a catchment area of 6700 acres. The total storage capacity will be about 1300 million gallons and the yield some 3 m.g.d. after allowing for compensation water equal to about 1 m.g.d. A second reservoir is proposed which would yield 2·7 m.g.d. after allowing for compensation water. For each impounding reservoir a separate service reservoir will be required at Crawley to store about two and a half days' supply of treated water, each of which will have a capacity of 4 million gallons. Work on the Weir Wood dam was started a year ago and is expected to be completed by the end of 1953. The second reservoir will not be constructed until the growth of Crawley and the demand of the other constituent authorities of the Weir Wood Water Board makes it necessary, which it is thought will be by about 1957.



MASTER PLAN OF CRAWLEY NEW TOWN

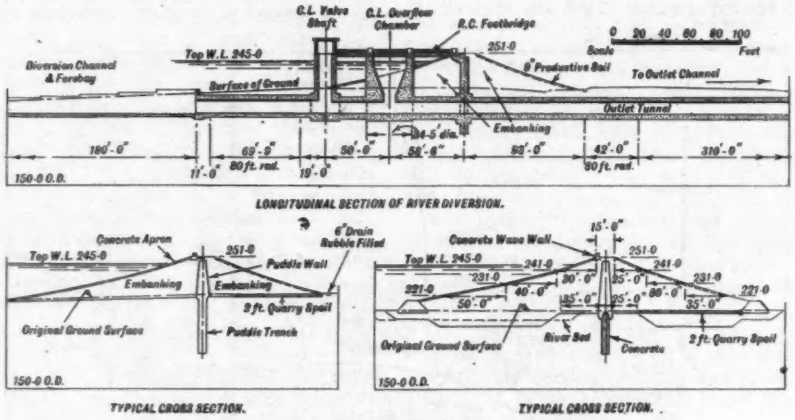
The dominant structure of the geology of the area in which the Weir Wood reservoir is being constructed is part of the Wealden anticlinal dome, whose major axial zone strikes south-east towards Hastings. The geological formation of the site is the Lower Cretaceous and the parts of the Cretaceous series forming the reservoir site are the two lowest, the Wadhurst clay and the Ashdown sandstone. The Ashdown sandstone, which forms most of the valley at the site of the embankment, is not so much a sandstone as a series of clays and silts with thin beds of sand and soft sandstone up to 20ft in thickness. Trial borings taken on the site seemed to indicate that there was a bed of blue clay at a reasonable depth, which would make a good watertight foundation. Trial excavations have shown that in the flat bottom of the valley there is a depth of alluvial deposit consisting mainly of soft,

silty clays on a gravel bed, which covers the main strata. This soft, silty clay is unsuitable for the base of the embankment and is being excavated and replaced.

The impounding reservoir will be formed by an earthen embankment about 1680ft long, 41ft high and 300ft wide at the base, with a top width of 15ft. A concrete cut-off wall will be sunk below the level of the base and an internal clay puddle wall carried to the top of the embankment. The river, when diverted, will flow through a 10ft diameter concrete tunnel about 1500ft long round the southern end of the embankment. When the reservoir is complete a bellmouth concrete overflow chamber will discharge into this diversion tunnel. On the line of the tunnel a concrete valve shaft will be constructed with two draw-off levels. Some details of this arrangement can be seen in the accompanying cross sections.

The treatment plant will be situated immediately downstream from the reservoir. The treatment will consist of coagulation with sulphate of alumina, settlement in sedimentation tanks, rapid gravity filtration and sterilisation by chlorine. After treatment the water will be pumped by electrically-driven centrifugal pumps to two existing service reservoirs at Ashurst Wood and Turners Hill and to two new service reservoirs at Turners Hill and Wych Cross, which will be constructed with mass concrete walls and reinforced concrete floors, columns and roof slabs. Their capacities will be 4 million gallons and 1 million gallons respectively.

The trunk mains will consist of steel pipes with Johnson coupling joints. The pipes will be internally lined and externally sheathed with bituminen and provided with cathodic protection as a precaution against corrosion. The pipe-line from Wych Cross to Nutley, which is to be used as a distributing main, will be of cast iron with mechanical joints.



WEIR WOOD DAM

has been taken over by the corporation and a 250,000 gallon reservoir constructed at Pease Pottage.

The reservoir is 50ft in diameter and 21ft high, and was constructed in prestressed concrete by Preload (Great Britain), Ltd. It is shown in cross-section in the accompanying sketch, from which the spacing of the prestressing wires may be observed. In the "Preload" system these wires are wound round the tank from a travelling carriage, which is suspended from a boom pivoted at the centre of the tank and projecting out above it, so that it revolves with the prestressing carriage. The carriage, which is shown in the photographs reproduced on pages 377 and 378, is driven by a petrol or compressed air motor, through wheels bearing on the side of the tank, and the wire winding is tensioned by passing it through a die to give a predetermined reduction in diameter, and hence the required tension; joints in the wire are made with "bulldog" splices. This system has been widely used in the United States, but the reservoir at Pease Pottage is the first example to be built in this country. The reservoir is intended as a temporary structure and is needed for five years only; it was constructed by placing 4in of pneumatic mortar on a single shutter, then winding on the prestressing wires, and finishing off with a ½in outside layer of pneumatic mortar.

	When supplying 3 m.g.d.		When supplying 5·08 m.g.d.	
	Pounds per annum	Pence per 1000 gals.	Pounds per annum	Pence per 1000 gals.
(*a*) Capital charges				
Weir Wood	47,767		47,767	
Proposed second reservoir	—		28,181	
	47,767	10·5	75,948	9·8
(*b*) Running costs				
Weir Wood Station	19,300		19,300	
Proposed second station ...	—		16,100	
	19,300	4·2	35,400	4·6
Total	67,067	14·7	111,348	14·4

In the whole scheme there will be about 13,000 lineal yards of 24in trunk main, 6800 lineal yards of 12in trunk main and 4900 lineal yards of 8in cast iron main. The accompanying table gives an idea of the costs of the scheme.

The distribution system for the new town consists of a ring main on the Crawley ring road with a network of subsidiary mains. Generally the pressures throughout the town will be of the order of 80 lb per square inch and for fire precautions in the town centre and industrial area allowance has been made during peak periods for a draw-off of 1500 g.p.m. In the residential areas the draw-off will be 500 g.p.m. The smallest pipe size is 4in diameter, and no 4in main will be more than 1000ft from a 6in main.

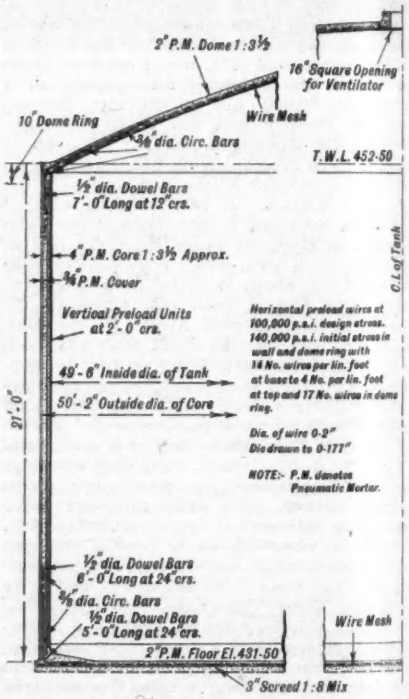
Since it will take some five years to complete these major works additional interim supplies had to be found as the water undertakers were not in a position to increase their supplies to the area. An arrangement was therefore entered into with the Mid-Sussex Joint Water Board, whereby that Board developed an intake on the Shell Brook at Ardingly in advance of their own requirements. This supply of 0·35 m.g.d. will become available to the new town in 1952 by means of a 6in asbestos cement pipe-line, which was laid from Balcombe to Crawley in the war years to supply troops in the area. The pipe-line

Drainage and Sewerage Systems

The new town will have separate systems for sewage and for surface water drainage. The fall of the ground is from south to north, which determined the position of the new treatment works at the north-east of the town, near Gatwick Airport. The surface water run-off which is to be expected when the whole area of the town is built up, was carefully investigated and much work has gone into the consideration of the problems involved. There are four main drainage areas within the designated area of the new town, the various streams all joining the River Mole, which flows into the Thames at Hampton Court. The Gatwick stream drains about 2500 acres, Crawter's Brook about 1100 acres, the Crawley Ditch some 600 acres, and the Ifield Brook and the River Mole itself about 1700 acres.

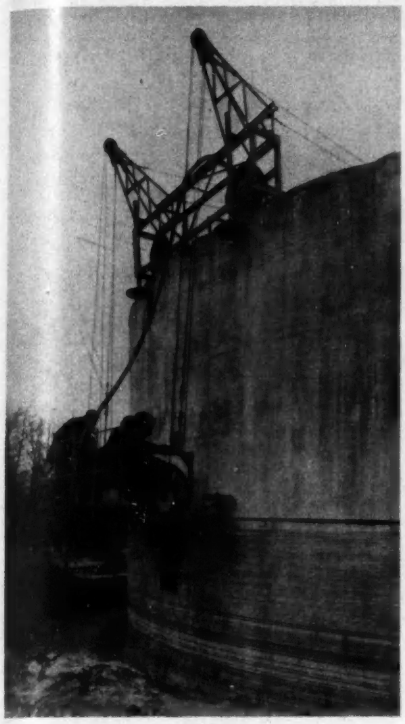
At an early stage in the design of the surface water drainage system discussions took place with the Thames Conservators to ensure that, subject to the carrying out of certain works on the River Mole, the increased flow from the new town could be taken without detriment to adjoining lands. Each of the catchment areas within the new town is now being dealt with in detail, the existing water-courses being widened and deepened or diverted and culverted where necessary. One of the first tasks was to set up temporary gauging stations to obtain some indication of the flood points in the area. These gauges consist of a series of small buckets fixed at 3in intervals to a tee-section stake, with a movable sleeve locked over to protect them from rain and damage. The maximum flood levels are determined by noting the highest bucket which contains water—the datum levels of the bucket gauges being known. These gauges were fixed alongside the streams at points where it was expected that flooding would take place. Three automatically recording rain gauges were placed at suitable points, which, in conjunction with gauging stations to be placed on the streams, will give valuable information on the relationship between rainfall and run-off in the area as the town develops.

The storm water system was designed by area time diagrams, the modified tangent


2" P.M. Dome 1:3½
16" Square Opening for Ventilator
10" Dome Ring
Wire Mesh
⅜" dia. Circ. Bars
T.W.L. 452-50
½" dia. Dowel Bars 7'-0" Long at 12" crs.
4" P.M. Core 1:3½ Approx.
¼" P.M. Cover
C.L. of Tank
Vertical Preload Units at 2'-0" crs.
Horizontal preload wires at 100,000 p.s.i. design stress. 140,000 p.s.i. initial stress in wall and dome ring with 14 No. wires per lin. foot at base to 4 No. per lin. foot at top and 17 No. wires in dome ring.
49'-6" Inside dia. of Tank
50'-2" Outside dia. of Core
21'-0"
Dia. of wire 0·2" Dia drawn to 0·177"
NOTE:- P.M. denotes Pneumatic Mortar.
½" dia. Dowel Bars 6'-0" Long at 24" crs.
⅜" dia. Circ. Bars
½" dia. Dowel Bars 5'-0" Long at 24" crs.
Wire Mesh
2" P.M. Floor El. 431-50
3" Screed 1:3 Mix

SERVICE RESERVOIR AT PEASE POTTAGE

method, Ministry of Health curve for rainfall intensities and on the Lloyd Davis formula, the impermeable areas being calculated from the lay-outs of the neighbourhoods. Having regard to the nature of the sub-soil, the fairly high impermeability factor of 20 per cent was taken for verges and 10 per cent for back gardens and open spaces. The total peak run-off in times of storm after the town has been built



WIRE WINDING CARRIAGE—PEASE POTTAGE RESERVOIR

up has been calculated to be 49,000 cubic feet per minute, or 306,250 g.p.m.

So far work on the Crawley Ditch has been proceeding and work will be commencing shortly upon Crawter's Brook. The largest culvert sections designed or constructed to date for these two works are single box culverts 9ft 3in wide by 4ft deep and a twin box culvert, each section being 6ft 3in wide by 5ft deep.

An interesting feature of the design of the surface water drainage works is the insertion of a flood storage basin at a low point in the area. This basin, which has a capacity of 1,200,000 gallons, will assist in dealing with the peak flows, which will be limited by an orifice to 12,000 cubic feet per minute, the excess flow which may reach 18,000 cubic feet per minute, being diverted over a weir into the basin. The provision of this flood storage reservoir may delay for some time the necessity for carrying out the widening and deepening of the streams below it. The widening and improvement of the River Mole beyond the designated area will require to be undertaken as the town develops.

Trunk Sewers and Disposal Works

The trunk sewers serving the new town are of 36in, 30in or 27in diameter and were designed for four times the dry weather flow of 65 gallons per head per day. Subsidiary sewers, however, were designed for six times the dry weather flow. Generally the trunk sewers follow the valleys of the various streams referred to in the previous section. Their gradients vary from 1 in 390 to 1 in 1000, being sufficient to give a minimum self-cleaning velocity of 2·5ft per second. In the town centre they are deep enough to drain basements not more than 8ft below ground level.

There is an existing disposal works to the west of the industrial area, which will continue to function until the first stage of the new works is completed. It will then be replaced by a pumping station, which will feed a rising main carrying sewage from the low-lying trunk sewers serving Gossops Green, Ifield Green and Langley Green. The other trunk sewers will all drain by gravity.

The accompanying diagram shows the lay-out of the disposal works, in which the effluent will be purified by the activated sludge system, and then discharged into the Gatwick Stream. The consulting engineers for the design of these works are Messrs. John Taylor and Sons. Construction will be in stages, according to the development of the town.

After initial settlement in primary settlement tanks the sewage will flow into aeration channels, where air will be blown through dome-shaped diffusers in the troughs of the channels, agitating the sewage and promoting oxidation. A flocculent mass of "activated sludge" is eventually produced by this process, which is allowed to accumulate, and is then aerated in admixture with a further quantity of settled sewage, colloidal and fine suspended matter in the sewage being absorbed by the sludge, whilst at the same time organic matter is oxidised as a result of biological activity. The sludge will then be separated in the secondary settlement tanks, part of it being returned for aeration in admixture with a further quantity of settled sewage from the primary tanks, and part returned to the primary tanks for settlement.

The extent of the first stage construction of the disposal works consists of the main pumping station, the power house, the main measuring flume, one primary settlement tank, five aeration channels, one secondary settlement tank, the sludge pumping station, grit channels, two sludge drying beds, a temporary sludge drying area, storage sheds, approach roads and ancillary works. The works are founded on clay and clay shales, and the construction is generally of reinforced concrete. The sludge gas will be collected as a source of power, so that the works will be self-supporting. The progress photograph reproduced overleaf shows the aeration channels, settlement tanks and, in the foreground, the roof of the power house.

Roads

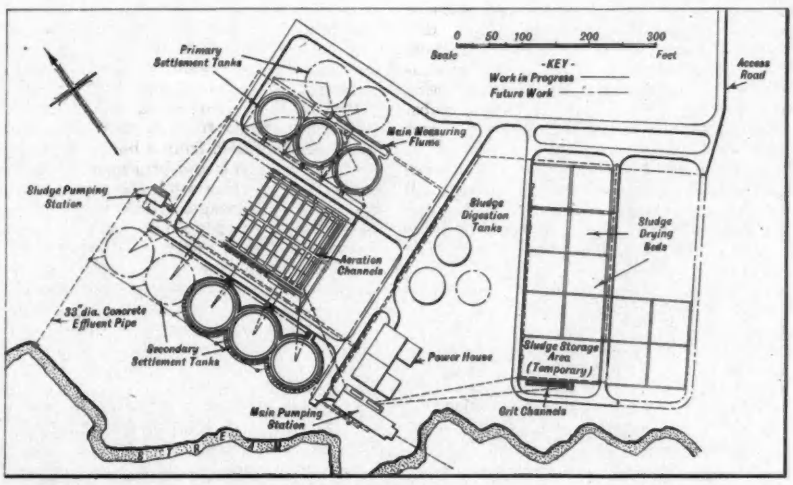
There are several interesting points about the system of roadways of the new town. It should be noted that the lay-out of the plan as a whole, envisaged that each neighbourhood, which contains a primary and nursery school, would be free from through traffic for reasons of road safety. Further road safety precautions include the provision of cycle tracks, which are not necessarily parallel with the ring and radial roads but give good routes for cyclists through the town. Studies were carried out to predict the traffic flow in the town when fully developed and the road design has been based on those results. One of the improvements which will be incorporated in the new road system is the elimination of the level crossing in the old town of Crawley, where the Horsham radial road will pass over the railway line on a single-span bridge, possibly of prestressed concrete. This work will require some demolition of existing buildings and is the only instance so far encountered where a substantial amount of demolition will be necessary. Some typical cross sections of the main and subsidiary roads are reproduced on page 378.

An arrangement which is widespread in this country but which is nevertheless regarded as irrational, is that of putting services in a trench under the road. The opportunity has been taken at Crawley of placing sewers and other services at the side of the carriageway, and in only two instances, due to a modification of the lay-out, can manholes be found in the carriageways. Where services have to pass under a road, ducts are provided so that maintenance may be effected without disturbing the road surface.

An idea of the carriageway designs may be obtained from the illustration referred to above. Soil tests were taken to provide a guide for road thicknesses, and for bituminous construction unconfined compression tests were made, whilst California bearing ratio and shear tests were taken where concrete carriageways were proposed. The Weald clay, which forms the subsoil of the greater part of the designated area, was found to be generally an inorganic clay of medium-high plasticity with liquid limit ranging from 40 to 60 per cent and a plastic limit of approximately 25 per cent.

Concrete roads were specified for the industrial area and for the radial roads, consisting of a 4in rolled concrete sub-base (12 : 1 mix), with an 8in main slab. The main slab was singly reinforced with additional top reinforcement at the ends and corners of the bays. The top 2in of the concrete roadway consists of a wearing surface of granite aggregate exposed by retarding and brushing to produce a surface pleasing in appearance and rough in texture. Skidding tests carried out on these surfaces by the Road Research Laboratory have shown sideways force coefficients of 0·68 and 0·78, the latter value being comparable with new tarmacadam or a new surface dressing.

Emphasis was given in the specification to several precautions intended to avoid changes in water content of the clay during construction. The sub-grade was to be covered with lean concrete or clinker within forty-eight hours of excavation and adequate drainage of the road was called for, together with the avoidance of trenches for services in the carriageway as noted above. Another important point in the design was the provision of a substantial concrete haunch on each side of the road; joints adjacent to the kerb face, which might allow water to penetrate to the sub-base, were avoided by laying the kerbs on the road slab or on the haunch. In all concrete work for the roads of the new town weigh-batching is specified with careful control of the water cement

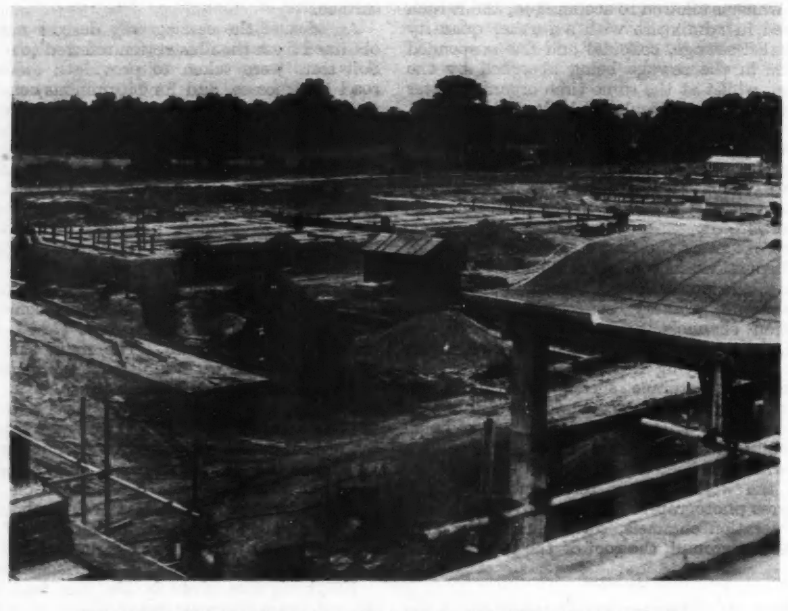


SEWAGE DISPOSAL WORKS

ratios. Concrete mixes have been designed generally on the grading curves and minimum values of compressive strength given in the Road Note No. 4 of the Road Research Laboratory.

For bituminous roadways it was decided that a construction depth of 18in was necessary to take heavy traffic (12,000 lb wheel loads) and 15in for medium traffic (9000 lb). These values were based on the assumption that the soil was not unduly disturbed so that the precautions mentioned above were again enforced.

It was decided, for several reasons, to construct the major part of the road pattern before house building started. Access for the building work would be good, large-scale construction after occupation of the houses would be avoided and the building traffic, it was thought, would show up any defects in the roads. However, it was realised that the roads would undergo severe punishment from the building traffic, so that kerbs and footways were not built, temporary kerbs only being provided. The main slabs of the concrete roads were built and a base coat of tarmacadam blinded with cold asphalt finished flush with the haunch was built for the flexible roads. The latter surface will be cleaned and made up with a covering surface of 1in of bitumen macadam or cold asphalt on completion and the temporary "in situ" kerbs, which are bonded into the slab or haunch with dowels, will become part of the backing of the permanent kerb.



DISPOSAL WORKS—AERATION CHANNELS AND SETTLEMENT TANKS

Experimental Work

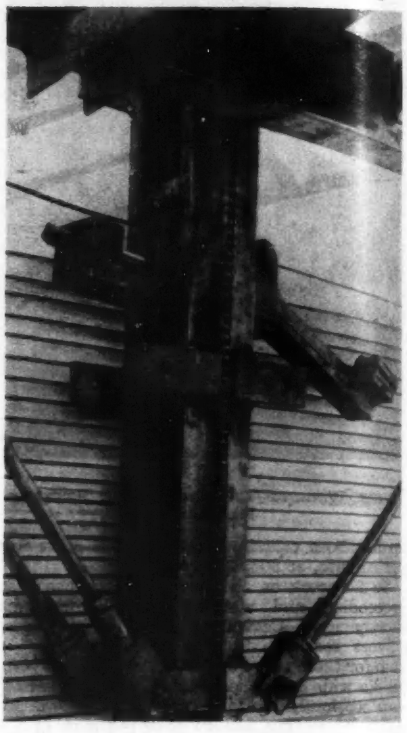
A limited amount of experimental work was carried out on the industrial site to obtain a finish to the concrete roads both pleasing to the eye and of non-skid texture. At first attempts were made (in co-operation with the Road Research Laboratory and the Cement and Concrete Association) to vibrate granite chippings into the main slab of gravel concrete. Results were extremely variable, however, and success depended too much upon the personal element. It was finally decided to use a top run of 1¼in thickness of Mountsorrel granite concrete, the surface of which was exposed by brushing and the limited use of a retarder, as mentioned above. Further work will be necessary to determine a satisfactory finish for "black-top" roads and footways, the most promising method being the use of cold asphalt and coloured chippings. It is also possible that slab pavings for footways with exposed aggregate finishes may be produced at reasonable cost.

Perhaps the most interesting experimental work, however, is the trial length of prestressed concrete roadway laid in the industrial estate. The design of this length was based on discussions between the chief engineer of the corporation, the Prestressed Concrete Company, Ltd., the Road Research Laboratory and the county surveyor of West Sussex. It consists of a 400ft length of carriageway, formed of a 4in clinker sub-base, with a thin layer of sand spread and rolled on it to reduce the frictional resistance, followed by a layer of waterproof paper, on which the 6in thick concrete slab was cast. The Freyssinet system of prestressing was used, with twelve-wire cables, aligned at an angle of 18 deg. with the line of the road in diamond pattern and 3ft 8in apart. The anchorage cones were fixed in concrete haunches constructed independently of the main slab and, owing to the difficulty of calculating the expansion of the 400ft bay, a short expansion bay 5ft in length, incorporating a 2in thickness of jointing material, was placed at each end, as a provisional measure until the expansion and contraction during a complete summer/winter cycle could be measured.

It is hoped to obtain some very useful information from observation on this experimental length with the aid of the strain gauges which have been incorporated in it. The main difficulty in design (which was the cause of the uncertain expansion mentioned above) was the determination of the sub-grade restraint, about which little information is available. It was decided that the coefficient of friction would probably lie between 0·25 (0·23 was the value estimated for the runway at Orly in France) and 0·50 (estimated by the Road Research Laboratory). The effect of this assumption is that for a length of 400ft of road, assuming the ends of the road to move relative to the centre, the sub-grade restraint will represent a decrease in prestress of between 50 lb and 100 lb per square inch. Therefore, by using a prestress of 200 lb per square inch a residual prestress of at least 100 lb per square inch would remain, which was thought to be sufficiently high to avoid cracking under load or temperature stress.

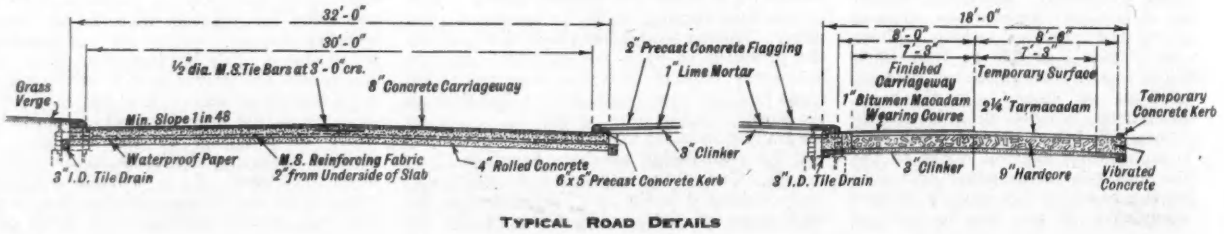
Other Services

Gas and electricity supplies for the new town are from external sources, gas being delivered from the Waddon Works at Croydon, where extensive additions are at present being made. There will be two gas holders of 4 million cubic feet total capacity near the industrial area, which will be supplied by a 24in and 18in diameter main. A new 132kV overhead line will augment existing electricity supplies to the town and various substations and a low voltage network are being constructed in the area. An extensive system of post office telephones is also being provided.



WIRE DRAWING DIE OF PRESTRESSING CARRIAGE

There are, however, various other engineering services which have been the subject of detailed study by the chief engineer and his staff. Mention has already been made of the studies concerned with stream-gauging and run-off, predictions of traffic flow and the experimental road works. Another subject which was studied in some detail was the provision of district heating, but it was decided that the addition of perhaps 10s. per week to the rents



TYPICAL ROAD DETAILS

of the houses would probably be a serious obstacle to the town's popularity with prospective inhabitants, and district heating has not so far been adopted.

The normal methods of the disposal of refuse are considered by many to be obsolescent, and various improvements were considered. A detailed study was made of the Garchey system of refuse disposal, which was reluctantly abandoned as being too expensive for the relatively dispersed population of the housing estates compared with blocks of flats. Another problem which may be mentioned is that of street lighting, where investigations indicated that fluorescent lighting would be the most suitable. Considerable thought has gone into the design of the street lamps and other street furniture and into the many other problems which have arisen.

Progress

Since work on the new town was started at the end of 1948, steady progress has been made with the design and constructional work, and at the time of writing a substantial proportion of the works described in this article have been built. At the end of the financial year last March, engineering work to the value of £1½ million was in progress, of which about a third had by then been completed.

Five miles of estate roads have been laid. In the industrial area, several factories for light industry have been built. They are generally of reinforced concrete construction with shell roofs. Up to the present fourteen factories are occupied and in use, with a total floor area of about 150,000 square feet. The number of houses built is about 340 and a further 620 are under construction.

The first stage of the sewage disposal works is now completed and in operation. Both the sewerage and the water supply, an idea of the progress of which was given earlier in the text, have been constructed under the supervision of the consulting engineers which were mentioned in the appropriate sections. All the other engineering services described in this article have been designed and built under the supervision of the chief engineer of the Crawley Development Corporation, Mr. A. J. W. McIntosh, and his staff. Our thanks are due to the chief engineer for his co-operation in preparing this article.

The principal contractors engaged on the work are listed herewith: Trunk sewers and surface water drainage: Gilbert Ash, Ltd., Howard Farrow, Ltd., Lavender McMillan, Ltd., Holloway Brothers (London), Ltd., Willment Brothers, Ltd., H. Pannett, Ltd. Sewage treatment works: Cementation Company, Ltd. Site development: Willment Brothers, Ltd., Turriff Construction Corporation, Ltd., Holloway Brothers (London), Ltd., H. Pannett, Ltd. Prestressed concrete reservoir: Preload (Great Britain), Ltd. Weir Wood dam: Richard Costain, Ltd.

The U.S. Atomic Energy Commission

Interesting details of the current work undertaken by the U.S. Atomic Energy Commission have been released in the Commission's latest six-monthly report to Congress. The Atomic Energy Commission conducted limited-scale weapons tests in January and February, 1951, on the Las Vegas Bombing and Gunnery Range in Nevada with logistic support by the military services. In April and May the Commission and the Department of Defence jointly conducted a full-scale test programme at the Eniwetok Proving Grounds in the Marshall Islands, in the Pacific Ocean. The Eniwetok tests included detonations of sufficient energy yield to permit checking or confirmation of the estimates and predictions of the effects of weapons several times more powerful than those used at Hiroshima and Nagasaki. Information obtained on phenomena associated with nuclear detonations, the major purpose of the tests, cannot be reported at present. Other experiments were carried out to determine the effects of atomic radiation, burns and blasts on living things, and to obtain additional data as to the effects of atomic weapon explosions on structures, aircraft and various materials.

Atomic Weapons Tests

The experience gained in the recent tests of atomic weapons demonstrated definitely that lingering radiation need not delay rescue and recovery work after bombing by high air bursts. Direct radiation from a high air burst was found to disappear almost immediately as the radio-active cloud rises into the stratosphere, and no dangerous residual radiation is left at ground level. A burst close to the ground leaves considerable residual radiation in an area 300 to 400 yards in radius, but destruction within this circle would be practically complete. After the explosions in the Eniwetok tests many scientists and technicians returned to the test sites promptly by helicopters and speed boats for periods long enough to recover instruments and specimens. Within twenty-four hours after one explosion construction employees, under radiological safety control, were able to begin work on new barracks situated 1000 yards from the point of detonation. The barracks were occupied seventy-two hours later.

For the primary purpose of providing data to develop treatments of atomic bomb casualties the tests at Eniwetok included the exposure of many mice and a few dogs and pigs under various conditions and at various distances from the explosions; all animals were anæsthetised before exposure. The experiments sought also to determine whether laboratory data on blast, radiation and burns could be applied directly to conditions of an actual bombing. The project was designed to verify the reliability of measuring instruments, to give accurate information on radiation exposures and energies at various distances from the bomb burst, and a detailed analysis of the relative effectiveness of infra-red, visible and ultra-violet portions of the electro-magnetic energy spectrum in causing flash burn injuries. More than 12,000 mice were used either in the actual exposures or to obtain "control" data. Mice were used because of the wealth of background laboratory data on this species; dogs because their reaction to radiation resembles that of man; and pigs because their skin resembles human skin. Many specimens were housed in special structures to protect them from all but one damaging component of the explosion. A number of mice, for example, were placed in chambers designed to admit nuclear radiations, but to exclude heat rays and the air blast. All animals used were bred and reared at Eniwetok so that effective studies with acclimated subjects could be carried out. Because of the tropical climate, battery-driven ventilating systems were installed in exposure chambers to reduce weather damage and get a clear picture of bomb effects. These measures were necessary because several hours elapsed between the time the specimens were placed in the chambers and the time they could be recovered after the explosion. Many of the specimens were examined at laboratories set up near the site. Some mice, which survived the exposures, were flow to the United States for continued observation. A preliminary analysis indicates the tests will provide definite answers on radiation distances, dosages and energies, and the factors involved in the thermal burns. Reports on the immediate effects of the tests are expected to be completed this year.

Buildings of various materials and of different construction were erected within range of the Eniwetok explosions to obtain information for building designs which would minimise blast damage. Some 900 measurements were made on twenty-seven different structures, including industrial buildings, dwellings, and underground and surface bomb shelters for military use. Glass and window construction were also given limited tests. Observations were made of physical damage, and instruments inside and outside the buildings automatically transmitted data on blast waves and nuclear and thermal radiation to recording stations placed at safer distances. This large collection of experimental data is now under analysis. It will supplement and bring up to date knowledge which previously was based on the effects of the Hiroshima and Nagasaki bombs.

A limited experiment on the effectiveness of motor-cars as a means of shelter against blast heat and radiation in an atomic explosion was made at the Nevada weapons test. Five cars were ranged at half-mile intervals from ground zero at one of the test explosions so that data could be obtained on the distances at which a car would afford some protection.

Raw Materials Supply

With regard to the supply of raw materials, the deliveries of uranium concentrates has increased during the last six months, and the Commission made progress toward increasing future supplies for its expanding production plant. Domestic production increased during 1950 and 1951 to the point where the United States has become the second among the free nations in the mining and processing of uranium ores. The programme to locate and define ore reserves in the United States expanded in the first six months of 1951, and 1,200,000ft of exploratory drilling is scheduled for the fiscal year 1952. Much of the exploration is directed toward maintaining and increasing production in established uranium-bearing areas, but all regions considered favourable are being studied. Drilling schemes are based on aerial mapping followed by detailed surface mapping and studies of available geological data. For the most part, diamond core drilling equipment is used, but non-core drilling also plays an important part in determining ore possibilities. In diamond drilling an annular diamond-tipped bit, rotated by a petrol engine driven drill rig, cuts through the rock formations. The core is recovered in a core barrel to which the bit is attached and is brought to the surface for examination and radiometric or chemical assay. Where no core is taken a specially designed probe is used to measure radio-activity in the bore-holes. Diamond drilling has uncovered excellent ore bodies. At one place, where the rim-rock of a mesa had produced a few hundred tons of uranium ore from a series of small deposits over thirty years, the deposits did not appear sufficiently attractive for private industry to prospect the mesa. As part of the drilling project, test holes were sunk in the mesa and revealed a very considerable body of uranium ore.

Production and Research

The Atomic Energy Commission has proceeded with the construction of new production facilities, and, while increasing the output of fissionable material in existing plants, has lowered the unit costs of both plutonium and uranium 235. Designs are well advanced for one of the two gaseous diffusion plants to be built on the site of the Kentucky Ordnance Works, 16 miles west of Paducah, Kentucky; and construction is going ahead on two power stations to supply electricity for the Paducah operations. Construction work has commenced at the Savannah River Plant, near Augusta, Georgia, where E. I. du Pont de Nemours and Co. will construct and operate a new major production centre.

Of the group of reactors under construction at the reactor testing station in Idaho, the one now nearest completion is the experimental breeder reactor. When it goes into operation the "EBR" will undergo a period of testing at low power levels to determine the operating characteristics of this first major reactor designed to operate with "fast" neutrons. The change to full design power will be gradual, and only at the higher power levels will a small generator be operated to produce experimental amounts of power for heat transfer studies. It is expected to take some time before specific information on breeding can be obtained. The reactor will use enriched uranium as fuel and a blanket of natural uranium around the core as the "fertile" material in which breeding may take place. The rate of fuel burn-up will be compared with the rate at which new fuel (plutonium) is manufactured. Since it is possible to breed new fuel at a rate faster than operating fuel is consumed, it may be possible to increase the supply of fissionable material beyond the 0·7 per cent of uranium 235 con-

tained in the natural uranium as mined and, eventually, to burn practically all the uranium rather than just a fraction of a per cent as at present. The practical problem of reactor designers is to ensure that as large a proportion as possible of the surplus neutrons goes into the manufacture of new fuel.

Construction has proceeded at the reactor testing station on the materials testing reactor, and the core and controls will be installed shortly under the technical supervision of the Oak Ridge National Laboratory. A test schedule is being set up for the "MTR," the prime purpose of which is to examine the performance of reactor materials in an intense neutron flux. The construction of buildings and facilities for two prototype submarine reactors—the submarine thermal reactor ("STR") and the submarine intermediate Reactor ("SIR")—is in progress. Construction has continued on a chemical processing plant at the reactor testing station for the separation of unused fuel from used fuel units. The full-scale plant is hoped to provide important new data on fuel processing, which begins with the dissolving of used fuel elements and the separating out of the unburned fissionable material. This material is reduced to metallic form, cast and fabricated into new fuel elements. Fuel elements go through this cycle at frequent intervals because the accumulation of fission products and the physical breakdown of the material during operation makes them useless.

Much more industrial participation is expected in future work of the Commission. A contract is being negotiated with the aircraft gas turbine division of the General Electric Company, of Cincinnati, for development studies on the problems of a nuclear reactor for aircraft. Early this year proposals from industry seeking a way for industrial firms to carry a larger share of the task of developing, building and operating reactors were studied by the Commission, and by the end of June agreements had been signed for four joint studies to be undertaken.

Among the three new particle accelerators put into operation during 1951, the 86in cyclotron at the Oak Ridge National Laboratory is believed to be the largest of its kind in the world. It accelerates protons to energies of more than 20 MeV without cutting back the number of impulses given each second to the speeding particles, and, consequently, is known as a "fixed frequency" cyclotron. The new 60in cyclotron at the Brookhaven National Laboratory has operated for short periods and produced deflected beams of 20 MeV deuterons. The synchrocyclotron of the University of Chicago has accelerated deuterons to 220 MeV. Plans are now in preparation for a new 63in cyclotron, intended to accelerate heavy ions above the weight of helium, which has been the heaviest projectile used so far in cyclotrons.

Construction has been started on a heavy water research reactor at the Argonne National Laboratory, in Du Page County, near Chicago. This reactor, the "CP–5," is intended to replace the "CP–3" reactor built in 1944 at the Palos Park Laboratory. The new reactor will be similar to the "CP–3," but of improved design. It will produce a more concentrated flux of neutrons for experimental work, will provide additional facilities for research, and can be used to produce limited quantities of some short-lived radio-isotopes of high specific radio-activity.

Studies of the properties of mesons are continuing at the University of California Radiation Laboratory at Berkeley. A study of the process of absorption in matter of negative pi-mesons (heavy mesons) indicated that this meson is absorbed by a single proton of an atomic nucleus and the recoil from the impact of the meson is shared among several nuclear particles. These particles in turn eject fast protons from the nucleus by direct collisions rather than by "evaporation" from the highly excited nucleus, as had formerly been believed. A new value has been obtained of the average time required for positive pi-mesons to decay into mu-mesons (light), which is considerably longer than earlier data indicated. Neutral mesons have been produced successfully by bombarding liquid hydrogen with gamma rays from the Berkeley synchrotron. Measurements were made of the yield of neutral mesons from hydrogen, deuterium, and oxygen by using ordinary water, heavy water, and liquid oxygen as targets in the 340 MeV proton beam of the 184in synchrocyclotron. The yield of mesons was proportional to the number of neutrons in the nucleus.

Finally, the manufacture and distribution of radio-active isotopes continued to expand during the last six months. The Oak Ridge National Laboratory has made more than 18,000 deliveries of radio-active isotopes to users in the United States and 1000 to foreign users since August, 1946, when distribution started. Between August, 1946, and May, 1951, the Laboratory made 6000 deliveries of radio-active iodine totalling 631 curies, 5000 deliveries of radio-active phosphorus totalling 220 curies, and 350 deliveries of radio-active cobalt totalling 607 curies.

Australian Engineering News

(From our Australian Correspondent)

Bridge Construction

Despite shortage of materials due to lack of manpower and difficulty in procuring labour, bridge-building in every State is being pushed forward as a vital need to meet the phenomenal increase in road freighting, which is the only answer to railway systems which cannot handle the volume of heavy goods, which must be carried inter-state and to country centres, where many companies are developing subsidiary or new activities. In the urban areas the traffic problem is particularly acute. Typical of recent progress is the new structure to span Cook's River in the Botany Bay district of Sydney, and which is now nearing completion. Expansion of the main airport at Mascot has involved the diversion of the tidal river channel, and construction of a bridge which is being built by the Department of Main Roads in dry terrain, before the excavation of the new channel. The ground, which is principally sand, has been excavated to a little above high-water level. Concrete cylinders have been sunk to the level of the reinforced concrete pile-heads. The piles have been driven inside the cylinders. The concrete girders are in eight simple spans of approximately 63ft, with three lines of girders to each half-bridge.

Demand for Fork-Lift Trucks

Until recently fork-lift trucks were in demand only for the handling of cased or bagged products but the requirements of the timber industry and other factors have stimulated production of such equipment to handle a greater variety of loads. One Adelaide manufacturing company has come into the market with a type of fork-lift truck, which it is claimed can be used with great success in the coastal timber mills, which are, as far as present disadvantages allow, working "flat-out" to meet the orders for housing and factory building supplies. Import difficulties have prompted Australian firms to undertake manufacture locally. A recent development in that direction is the "Hyster," made here under licence from the U.S. factory of that name. This fork-lift truck has a lifting capacity of more than 4000 lb and has been designed to meet the needs of a wide range of industries.

Increasing Market for Plastics

It is reported that Imperial Chemical Industries of Australia and New Zealand, Ltd., intends to spend £3,000,000, over a period of three years, for the extension of its Sydney plant. The purpose is to step up the manufacture of polyvinyl chloride, a basic material, from 1000 tons to 6000 tons a year. Hitherto Australian manufacturers have had to contend with shortage of supplies and to import "P.V.C." from abroad.

French Engineering News

(From our French Correspondent)

At the Gas Industry Congress, recently held at La Baule, Monsieur Edmond Lesaune, an engineer of the Lievin group, presented an interesting report on an experiment to remove the gas from the mines of the Nord and Pas-de-Calais basin. The gas is brought to the surface by a 200mm pipe, with double filters and water seals, by means of an extractor at the surface. The fire-damp thus collected is then sent to the Drocourt coking plant, to be mixed with gas from the Lievin plant. The extra supply obtained is delivered to the Gaz de France network. Should the extension of this process prove advantageous, the coal-mines will probably install a small network of mains for collecting the fire-damp, to be sent to a treatment station. Other methods of extracting the fire-damp are also envisaged, which, it is hoped, will give a greater quantity of gas, richer in methane.

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French automobile production during the first half of 1951 amounted to 158,260 private cars, against 122,800 during the corresponding period last year, and 63,077 industrial vehicles, against 45,720. Exports during the first half of 1951 amounted to 51,981 cars (33 per cent of production) and 17,818 industrial vehicles (27 per cent of production). The principal foreign buyers for private cars were the Belgo-Luxemburg Union and Sweden, with Australia third. Renault exported 13,271 cars, Citröen 11,616, Peugeot 6541, Simca 3015, Panhard 1272 and Ford 1000.

* * *

French coal imports for July reached the highest figure since the beginning of the year, amounting to 1,142,922 tons, against 725,005 tons in January. Germany supplied 519,094 tons and America 422,425 tons. The average monthly import for 1950 was 750,000 tons. While the additional coal will assist in raising steel production, the difference in price between imported and nationally produced coal may cause a rise in price. Until now French coal has been subsidised, and further credits will be necessary to avoid increased prices.

* * *

Installation of the first of the six vertical-axis Kaplan turbines, which will equip the André Blondel power station of the Donzere-Mondragon project of the Compagnie Nationale du Rhône, has been completed (see THE ENGINEER, December 8 to 29, 1950, for a full description of this work). The designed flow for this 70,000 h.p. turbine is 255 cubic metres per second, with a head of 22m; it will drive a 50MW alternator and power generation will start in Feruary, 1952. The five other turbines will be installed as the work advances, one every two months, the annual production of the completed power station being about 2 milliard kWh.

Altogether, 2,850,000,000 francs from Marshall Aid counterpart funds has been allocated to the work. The long head-race canal will gradually be filled, starting this month, and the tail-race canal towards the middle of next January. The permanent diversions of Route Nationale 7 and the Paris-Marseilles railway line across the tail-race canal will be completed during December.

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The Chastang reservoir on the Dordogne will be filled shortly. Average production of the plant will be 540 million kWh, with an installed capacity of 225MW.

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The Sté. Energie Electrique du Maroc has reached an advanced stage in its development programme for the Oued El Abid. The first stage in the construction of the Bin el Ouidane barrage has been completed and work on the compensating barrage of Ait Ouarda has started. Several new thermal power stations will also be ready for service shortly. The Salé plant is being supplemented by the installation of three 1450 h.p. diesel generators and the 60kV and 22kV distribution system is being developed.

Industrial and Labour Notes

Railway Wages

Last week, the Railway Executive published details of the wage increases which it was prepared to offer in response to the claim made jointly by the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association. The claim was for an all-round increase in salaries and wages of 10 per cent.

The proposals made by the Railway Executive provided for increases in salaries and wages for all the staff—about 450,000—included in the unions' claim, and also for additional flat-rate payments for full turns of duty booked to begin on Saturday afternoons. The increases ranged from 4s. 6d. a week to 15s. a week in the wages grades and up to £50 a year in the salaried grades, and it has been estimated that the cost of putting them into effect would have been about £9,500,000, compared with about £18,000,000 involved in the unions' demands. In making its proposals, the Railway Executive stated that consideration had been given to the increased cost of living since the last wage increase in January this year. The proposals had also been designed particularly to assist in stemming the drift of key staff from the railway service to industries paying higher rates of wages, and to attract to the railway industry staff for those grades.

At a meeting of representatives of the three unions and representatives of the Railway Executive on Tuesday of last week, however, the unions indicated that the proposals were not acceptable. Subsequently, it was stated that the unions had decided to refer their claim for a 10 per cent increase to the Railway Staff National Council.

Employment and Unemployment

According to the latest report by the Ministry of Labour on the employment situation in Great Britain, the working population increased during July by 39,000 (14,000 men and 25,000 women), bringing the total by the end of the month to 23,366,000 (15,966,000 men and 7,400,000 women). Of that total, there were 22,333,000 (15,023,000 men and 7,310,000 women) in civil employment at the end of July.

The labour force of the basic industries of the country numbered 4,187,000 at the end of July, or 15,000 more than at the end of June. Most of the increase was in agriculture. Manpower in the coal mining industry declined by 1000 during July, the number of wage earners on colliery books at the end of the month being 700,000, which was 11,000 more than at the end of last year. In the manufacturing industries, the total number of people employed at the end of July was 8,683,000, there being a net increase of 7000 during the month. In the "metals, engineering and vehicles" group there was no change in July, the labour force remaining at 4,105,000. In the building and contracting trades manpower declined during July by 5000 to 1,447,000, but in "professional, financial and miscellaneous services" there was an increase of 4000 in the number engaged, bringing the total to 3,960,000.

The Ministry's latest statistics on unemployment relate to August 13th, and for the first time in several months show an increase in the number of people registered as out of work. The total on August 13th was 204,884, compared with 185,847 on July 16th. The August figure included 11,257 described as "temporarily stopped."

Iron and Steel Production

British steel production during August was again affected by the annual holidays and averaged 266,400 tons a week, which represented an annual output rate of 13,855,000 tons. It was an improvement on the preceding month, when output was running at an annual rate of 13,317,000 tons. In August last year, steel production was at an annual rate of 14,530,000 tons. Pig iron production last month averaged 180,900 tons a week, representing an annual output rate of 9,409,000 tons. In July, the annual rate was 9,484,000 tons and, in August last year, 9,205,000 tons.

Copper Prices

A reduction of £7 per ton in the price of electrolytic copper was announced last week by the Ministry of Materials, making the current price £227 a ton delivered consumers' works. This reduction, which took effect on September 13th, has been made possible by the Ministry's decision not to buy copper for the time being at prices exceeding the quoted American f.a.s. export price. Discounts, premiums on special shapes, and the limitations on forward purchasing arrangements are unaltered.

Corresponding adjustments in the controlled maximum prices of copper scrap and unwrought brass have been made by an order from the Ministry of Supply. It is the Non-Ferrous Metals Prices (No. 7) Order, 1951, and it contains full details of the reductions. The Ministry of Supply has stated that written contracts made before September 13th, which were legal under the earlier non-ferrous metals prices Orders, are not affected by this new Order, but any options exercised or contracts renewed after that date must conform to the prices now announced.

Register of Industrial Premises

As recorded in these notes in our issue of August 3rd, the Government has decided to create a small organisation, under Sir Philip Warter, within the Board of Trade, which will be responsible for the establishment of a Control of Factory and Storage Premises in the event of an emergency. This organisation is now known as the Factory and Storage Premises (Defence Planning) Division.

As one of its first tasks the Division is bringing up to date its register of industrial premises, and industrialists throughout the country will shortly be receiving from Board of Trade Regional Controllers a letter asking them to supply certain basic information about their premises. By limiting the approach to firms occupying a floor space exceeding 5000 square feet, and omitting those industries which are already heavily committed to the rearmament programme, only about one-third of the industrialists throughout the country will be asked to complete the short questionnaire. The Board of Trade says that industry can be assured that the information obtained through this appeal will be regarded as strictly confidential and only used for the purposes of the register as an essential part of the country's defence plans.

Census of Production for 1951

The Board of Trade has made a statement about the collection of information concerning power equipment, fuel usage and shift working in connection with the Census of Production for 1951. It says that details on these matters will normally be required for the week ended September 22, 1951, and will be required from all establishments included in the Census of Production, employing more than ten people on the average, except textile converters, builders and contractors, and the building and civil engineering departments of local authorities, railway, tramway and canal undertakings.

Firms are being asked to state the total installed capacity on September 22nd, and reserve or idle capacity during the week ended on that date of the following:—The various kinds of prime movers driving generators, expressed in terms of brake horse-power for reciprocating internal combustion engines, and horsepower in all other cases; the various kinds of prime movers not driving generators; generators expressed in terms of their rated maximum continuous capacity in kilowatts; electric motors expressed in terms of maximum continuous brake horsepower, distinguishing as far as possible between those driven by purchased electricity and those driven by electricity generated within the works, with separate particulars of the number and capacity of fractional horsepower motors of less than 1 h.p. Questions will also be asked about the description, duration and number of shifts worked in the week ended September 22nd, the average number of operatives employed on each shift during the week, and the average number employed during the week other than on shift working.

If, for any reason, the week ended September 22nd is not a normal week, the particulars will be required for the nearest ordinary week. The Board of Trade adds that special arrangements for coal mines, petroleum refineries, and gas and electricity undertakings, are being made in co-operation with the Ministry of Fuel and Power.

The Coal Board's Statistical Statement

The National Coal Board's statement on production costs, proceeds and profit of collieries for the second quarter of 1951 gives the saleable output from the Board's mines as 53,184,852 tons, of which 49,319,845 tons were disposable commercially. The saleable output in the first quarter of this year was 53,323,361 tons.

Production costs in the second quarter amounted to £127,979,331, wages, including holiday pay and allowances in kind, taking up £82,974,386. Proceeds from the sale of coal totalled £136,834,476, so that the profit, before charging interest, is shown as £8,855,145. Profits of the Board's ancillary undertakings have been estimated at £550,000, making the total proceeds £9,405,145. From that sum there had to be deducted interest, provision for miners' pensions (£500,000), losses on imported coal (£1,225,000), and provision for profits tax, which brought the profit for the quarter to £6,855,145. The interest payable to the Minister of Fuel and Power has been estimated at £3,750,000, leaving a surplus for the second quarter of £3,105,145. The Board points out that in the corresponding quarter of 1950 the surplus was £2,451,971, and in the first quarter of this year £983,100.

In some general observations on the statement, the Board says that, during the second quarter of 1951, costs showed further increases and there were continued losses on imported coal; but the total proceeds were, of course, influenced by the increase in inland selling prices of coal which was made in February last. Production costs were actually 1s. 3·5d. a ton higher than in the first quarter, mainly as a result of increases in national minimum wage rates and Saturday working at overtime rates. Output per man-shift was 0·5 cwt lower than in the first quarter. Average weekly earnings during the second quarter were £10 12s. 7d. for underground workers, and £7 17s. 11d. for surface workers, both figures including the value of allowances in kind, which are estimated at 8s. 7d. and 8s. respectively. Saturday working continued during the quarter until June 2nd, and the Board says that, although the output obtained by it was less than in the first quarter of the year, it was greater than in the second quarter of 1950.

Notes and Memoranda

Rail and Road

THE NEWCOMEN SOCIETY.—The Newcomen Society for the Study of the History of Engineering and Technology is arranging an autumn one-day meeting on Friday next, September 28th. It is to be devoted to traversing the routes of the early railways in Surrey, under the guidance of Mr. Charles E. Lee. The opening meeting of the Society's new session will be held on Wednesday, October 10th, at 5.30 p.m., at the Science Museum, South Kensington, S.W.7, when Mr. E. A. Forward, M.I.Mech.E., will present a paper entitled "Chapman's Locomotives, 1812–1815."

ROAD AND RAIL TRAFFIC ACT (EXEMPTION) REGULATIONS.—The regulations granting exemption in certain cases from the requirement of the Road and Rail Traffic Act, 1933, that a goods vehicle shall not be used for the carriage of goods for hire or reward, or in connection with a trade or business, except under a carrier's licence, have now been consolidated. At the same time, the Minister of Transport has extended the list of exemptions to cover other uses of vehicles which are technically goods vehicles and would otherwise require carrier's licences. Copies of the regulations, entitled "The Road and Rail Traffic Act (Exemption) Regulations, 1951," can be obtained from H.M. Stationery Office.

Air and Water

PORT AUX BASQUES WHARF.—A new wharf, 1040ft in length, is to be constructed at Port aux Basques, Newfoundland, to accommodate the passenger and motor-car ferry at present building in Montreal. When completed the whaff will form the terminus in Newfoundland of both the railway and the trans-Canada highway.

INSTITUTE OF MARINE ENGINEERS.—The next examinations for admission to the Institute of Marine Engineers will be held as follows :—Students (common preliminary examination), April 1 to 4 and October 7 to 10, 1952; Graduates (Sections A and B of the associate membership examination), April 28 to May 21, 1952; Associate Members, April 28 to May 22, 1952. Syllabuses of these examinations, and particulars of exempting qualifications, will be supplied on application to the Secretary, at 85, Minories, London, E.C.3.

Miscellanea

LECTURES ON ENGINEERING METROLOGY.—A course of twelve lectures on the subject of "Engineering Metrology" is to be given at the Royal Technical College, Glasgow, during the coming sessions. The lectures will be delivered on Thursday evenings at 7.30 p.m., beginning on September 27th, and the fee for the course is two guineas.

THE LATE MR. E. M. W. BOUGHTON.—We have learned with regret of the death, on September 8th, of Mr. Edward Morley Westwood Boughton, manager of the Birmingham works of the British Thomson-Houston Company, Ltd. Mr. Boughton, who was in his sixty-fifth year, joined the company as a draughtsman in 1910, and had been manager of the Birmingham works since April, 1941.

F.B.I. ACCOMMODATION SERVICE.—The Federation of British Industries has opened, for the use of its members, a service flat containing eight single bedrooms and one double bedroom at Whitehall Court, London, S.W.1. The cost of the single rooms is 22s. 6d. a night, and of the double room 37s. 6d., and bookings can be made by the Travel Department, Federation of British Industries, 41, Buckingham Palace Road, London, S.W.1.

INSTITUTION OF ENGINEERING DRAUGHTSMEN.—The Institution of Engineering Draughtsmen and Designers has announced the award of honorary membership to the following :—Mr. Gilbert Roberts, M.I.C.E., of Messrs. Freeman Fox and Partners; Mr. F. R. Bell, engineer-in-charge of the turbine division of the Rover Company, Ltd.; Mr. Cecil Cooke, director of exhibitions, Festival of Britain, 1951, and Mr. Ian Cox, M.A., director, science and technology, Festival of Britain, 1951.

REFRESHER COURSE FOR WORKS ENGINEERS.—A refresher course for works and plant engineers is to be conducted at the College of Technology, Birmingham, on Friday evenings—for a period of twenty-three weeks—beginning October 12th. The syllabus for the course has been designed not only to increase knowledge, but to make better use of existing knowledge, and to promote the application of up-to-date techniques in works engineering practice over a wide field. The subjects include planned maintenance; modern developments in mechanical transmission of power; materials handling plant; lubrication; combustion and steam raising; steam utilisation; distribution and utilisation of electricity; heating and ventilation; surface treatment of metals and alloys; compressed air plant; pumping plant; instrumentation of plant; the plant engineer and management. The fee for the full course is £3 3s. Full particulars can be obtained from the Registrar, College of Technology, Birmingham, 1.

ATOMIC ENERGY INFORMATION.—Representatives of Canada, the United Kingdom and the U.S.A. have been meeting in Washington to discuss principles of declassification of atomic energy information. The Ministry of Supply says that recommendations resulting from the discussions are to be reported to the atomic energy agencies of the three Governments for review before any final revisions in the uniform declassification guide are made.

CENSUS OF PRODUCTION FOR 1948.—The first section of the final report on the Census of Production for 1948 has now been published. It includes the introductory notes and the report on the blast-furnaces trade. The complete final report will include 156 separate booklets corresponding to the trades covered by the census. The introductory notes describe and explain the scope and methods of the census, the basis of the questions asked, and the calculations made in compiling the figures shown in the trade reports.

BEET HARVESTING MACHINERY DEMONSTRATION.—The sixth annual demonstration of sugar beet harvesting machinery, arranged by the British Sugar Corporation, Ltd., and the National Agricultural Advisory Service, is to be held at Oxton, near Nottingham, on Thursday and Friday, October 18th and 19th. It is expected that eighteen machines in the production classes and ten machines in the development classes will be shown at work. Mobile drying units for drying the beet tops will also be operating during the demonstration.

LECTURES ON THE DESIGN OF WELDED STRUCTURES.—We have received particulars from the Quasi-Arc Company, Ltd., Bilston, Staffordshire, details of an evening course of lectures on the design of welded structures, which will be held in London from October 16th next to December 4th. The course is intended for structural designers and draughtsmen already familiar with structural design. Further details may be obtained from the constructional design department of the company at the address given above.

INSTITUTE OF PHYSICS.—The X-ray analysis group of the Institute of Physics is arranging an autumn conference on "The Structures of Silicate Minerals." It will be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2, on Friday and Saturday, November 2nd and 3rd. The first session will begin at 2.15 p.m. on November 2nd, when the subject of "Calcium Silicates" is to be discussed. In the evening, at 8.30 p.m., Dr. W. H. Taylor will lecture on "Felspars." On Saturday, November 3rd, at 9.45 a.m., the subject for discussion is "Clay Minerals and Asbestos."

THE LATE MR. J. E. SOUTHCOMBE.—We have learned with regret of the recent death of Mr. J. E. Southcombe, a director of Germ Lubricants Ltd. Mr. Southcombe, who was sixty-six, graduated at Liverpool University in 1907. During the first world war, he collaborated with the late Mr. Henry Wells in an investigation of the properties of "fatty oils" and their use as compounding agents with mineral oils for lubrication. Mr. Southcombe joined the board of Henry Wells Oil Company, Ltd. (later renamed Germ Lubricants, Ltd.), in 1929, and since then had taken a prominent part in that firm's development, not only on the technical side, but also on the administrative. He was a Fellow of the Institute of Petroleum and the author of "The Chemistry of the Oil Industry" and "Lubricating Oil Tests and their Significance."

SOUTH-WESTERN ELECTRICITY CONSULTATIVE COUNCIL.—At a meeting on September 14, 1951, in Exeter, the South-Western Electricity Consultative Council considered a statement by the Board on the effect which the revision of the capital allocation for 1952 would have on the Board's rural development programme. The Council passed a resolution viewing "with great concern the report of the South-Western Electricity Board that, following the proposed Government restrictions on rural development, which emphasised that predominantly industrial areas will rank for first consideration, they do not feel justified in initiating any more negotiations for rural development schemes." The resolution concluded "that agriculture should rank equally with other sections of essential industry for the allocation of capital for new supplies of electricity."

THE ROYAL PHOTOGRAPHIC SOCIETY'S ANNUAL EXHIBITION.—The ninety-sixth annual exhibition of the Royal Photographic Society was opened on September 13th at 16, Prince's Gate, London, S.W.7. The public is admitted free until Sunday, October 14th, from 10 a.m. to 8 p.m. daily (Saturdays, 10 a.m. to 5.30 p.m.; Sundays, 2.30 p.m. to 5.30 p.m.). Besides pictorial photography, which provides the main interest of the exhibition, there are examples of scientific, stereoscopic, record and industrial photography, in monochrome and colour. After the London display the whole exhibition will be transferred to the City Art Gallery, Aberdeen, and will be on view there from November 3rd to 24th inclusive.

NEW 33kV SWITCHING STATION AT BIDEFORD.—Following the extension of the 132kV grid from Taunton to East Yelland, the South-Western Electricity Board has constructed a major switching station at Bideford. This station forms part of a scheme to improve the high-voltage network in North and West Devon by accepting 33kV supplies from the power station being built at East Yelland, which should begin to come into commission in 1952. The Bideford switching station will enable the existing 33kV system to be greatly extended, reinforcing the 11kV network on which demand is steadily increasing. The substation consists of five 33kV oil circuit breakers and associated isolators, busbars, &c. The circuit breakers are 400A, 500MVA (type "ORT 2"), manufactured by A. Reyrolle and Co., Ltd.; the isolators, made by Switchgear and Equipment, Ltd., are 400A horizontal single-break units. The B.E.T. transformers are 3MVA, 33/11kV, with fully automatic on-load tap changing.

Personal and Business

KERRY'S (GREAT BRITAIN), Ltd., Warton Road, London, E.15, has opened new showrooms at Furnival Street, Sheffield, 1.

MR. H. C. REEVES, B.Sc. (Eng.), A.M.I.C.E., has been appointed chief fan designer of Air Control Installations, Ltd., Ruislip, Middlesex.

AVICA EQUIPMENT, Ltd., has now moved to its new offices and factory at 1, Adams Place, Georges Road, Holloway, London, N.7 (telephone, North 4281).

MR. F. R. MASON, B.Sc. (Tech.), has been appointed a director of Metropolitan-Vickers Electrical Export Company, Ltd., Trafford Park, Manchester.

MR. C. L. FISHER has been appointed manager of the British sales division of the Consolidated Pneumatic Tool Company, Ltd., 232, Dawes Road, London, S.W.6.

BRITISH INSULATED CALLENDER'S CONSTRUCTION COMPANY, Ltd., announces the retirement of Mr. A. H. Honsfield, district engineer at Dewsbury, after over thirty-seven years' service.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., announces the retirement of Mr. A. E. Bartram from the turbine construction department, after thirty-one years' service with the company.

MR. R. W. TAYLOR, A.M.I.E.E., has been appointed product sales manager of the Nelson stud welding service of Crompton Parkinson, Ltd., in succession to Mr. R. V. Powditch, A.M.I.Mech.E., A.M.I.E.E., who becomes product sales manager, fractional horsepower motors.

BABCOCK AND WILCOX, Ltd., states that Mr. C. H. Davy, M.I.Mech.E., has been appointed works director at the Renfrew and Dumbarton works. Mr. I. M. Lyon, M.I.Mech.E., continues as general manager of the Renfrew and Dumbarton works. Mr. T. B. Webb, A.M.I.Mech.E., has been appointed chief research engineer.

THE STEEL COMPANY OF WALES, Ltd., states that Mr. David J. Young, who has been secretary since the formation of the company in 1947, will in future be entitled secretary and comptroller. It is also stated that, as from October 1st, the Orb Works at Newport, which has operated as the Steel Company of Wales (Lysaght Works), Ltd., will be known as the Lysaght Division of the Steel Company of Wales, Ltd.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces the retirement of Mr. G. H. Fletcher, M.I.Mech.E., M.I.E.E., as general manager of the Attercliffe Common Works, Sheffield. Mr. R. P. Knight, A.M.I.E.E., has succeeded him. The company also announces the appointment of Mr. A. H. Harle, A.M.I.E.E., as manager of a new sub-office which has been opened at 78–80, Hanover Street, Edinburgh (telephone, Central 6784).

British Patent Specifications

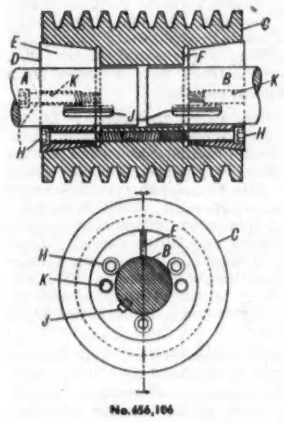
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

SHAFT COUPLINGS

656,106. October 6, 1948.—A Shaft-Fastening Assembly, Thomas Levi Fawick, of 17815, Shaker Boulevard, Cleveland, Ohio, U.S.A.

Referring to the drawings, the assembly comprises a pair of shafts *A* and *B* joined by an annular, rotary member *C*, which can be a multiple V-belt pulley, as shown. At each end the member *C* is formed with a conical inner face tapered toward the middle for reception of a wedging ring *D*, which is formed with a "split" or gap at *E* to permit contraction against the shaft. The member *C* has a wide internal annular flange *F* which is formed with threaded holes *G*. Bolts or screws *H*, with clearance, holes formed in the wedging rings,



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are screwed into holes in the flange *F* from opposite ends. The clearance between the screws and the walls of their holes in the wedging rings permits the use of a key *J* mounted in keyways formed in the inner face of the ring and in the shaft, without the key interfering with even radial wedging action. For forcing them out of their seats in the dismounting of the assembly, each of the wedging rings is formed with holes *K*. Each hole has a small-diameter inner end portion threaded for screwing the threaded end portion of one of the screws *H* as illustrated. The screws push against a side face of the internal flange of the annular member and thus force the wedge rings out of their tapered sockets. A modified design is also shown in the specification.—*August* 15, 1951.

METALLURGY

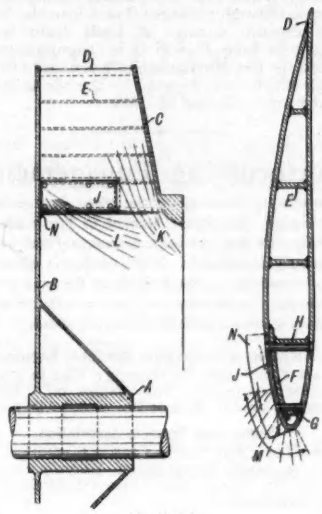
656,587. October 1, 1948.—An Explosive Method and Device for Tapping Blast Furnaces, E. I. Du Pont de Nemours and Co, Wilmington 98, Delaware, U.S.A.

The shaped charge of this invention consists of a detonating explosive in such a form that it presents a hollowed-out surface on one side or end, which faces the point to be penetrated. When the explosive is detonated, the metal liner is projected forward in a pencil-like jet of very high velocity and penetrating power. This jet has such penetrating effect that when using the more efficient types of explosive and the more effective shapes of hollowed-out surface, as little as ½ oz of explosive can penetrate about 5in of armour plate. For maximum effect, the charge should have a stand-off distance of about 2 to 4 charge diameters from the adjacent face of the body to be penetrated.—*August* 29, 1951.

AIR COMPRESSORS AND BLOWERS

656,336. January 3, 1949.—Centrifugal Fans, Koninklijke Machinenfabriek Gebr. Stork and Co., N.V., of Hengelo, The Netherlands.

Referring to the left-hand drawing the impeller, with its hub *A*, is secured to the shaft and carries several blades of streamlined shape which are welded to the back wall *B* of the impeller and a supporting ring *C*. The blade walls are bent from plates which are welded together at *D*. Between the plates supporting ribs *E* are welded. The plate at the inflow side only of the impeller extends to the entrance edge of the blade, but for the rest is cut away, and at this place the blade is closed by an additional plate *F*. At its entrance end the blade is closed by a strip *G* welded between the plates and a second strip *H* is welded between the plates for strengthening the blade. In the recess formed by the plate *F* the shape of the blade is completed by a wearing plate *J* secured by rivets extending through both the plates. From the left-hand



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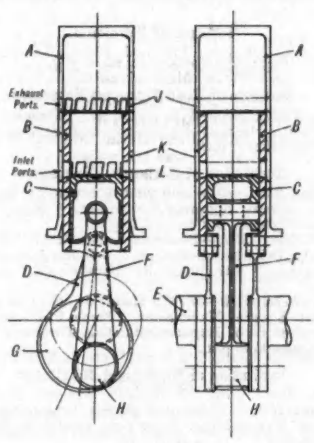
drawing, in which the flow of the gases is indicated by lines *K* and the flow of the solid particles by lines *L*, it appears that the wear of the blade is limited to a portion only along the entrance edge of the blade extending to the back wall of the impeller. In the other drawing, the zone subject to wear is indicated by the arc *M*. As the zone of wear extends to the back wall of the impeller the plate *J* is provided with a flange *N* lying against the back wall of the impeller.—*August* 22, 1951.

INTERNAL COMBUSTION ENGINES

656,421. January 6, 1949.—An Internal Combustion Engine, George Parker, of 253, Station Road, Hayes, Middlesex.

The invention consists of a two-stroke internal combustion engine comprising a sleeve valve in which the piston reciprocates, the valve alone controlling the exhaust ports whilst the inlet ports are controlled by both the piston and the valve, which is connected directly to the crankshaft so that it serves as a second piston and imparts to the crankshaft at least one-sixteenth of the total power output of the engine. The cylinder *A* is closed at one end and is provided with two movable pistons *B* and *C*. The piston *B* during the operation of the engine



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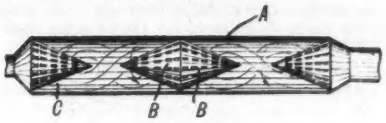
slides freely inside the cylinder and acts as a sleeve valve. It is connected by a rod or rods *D* to a crankshaft *E*. The inner piston *C* slides freely inside the ring piston and is connected by a rod *F* to the crankshaft. On the crankshaft are eccentrics *G*, which operate the rods *D*. They are radially positioned about the crankshaft so as to lead the crankpin *H* during the rotation of the crankshaft. The cylinder has a number of exhaust ports *J* at its upper end and a number of inlet ports *K* towards its lower end. The ring piston *B* is provided with inlet ports *L*, which co-operate with the ports *K* in the cylinder. The combined movements of the ring piston *B* and the piston *C* control the opening and closing of the inlet ports while the ring piston alone controls the opening and closing of the exhaust ports.—*August* 22, 1951.

656,552. October 6, 1947.—Internal Combustion Engine Exhaust Silencers, Gustave Plasse, 27, Rue Dabray, Nice, France.

The silencer illustrated in the drawings includes a tube *A*, which is secured to the exhaust pipe of an engine. Inside the tube are arranged metal sheet conical members *B*. These cones are secured together through their bases and open freely into one another without any perforated partition between. They are provided with series of short rectilinear slots *C* separated from one another and extending along helical lines. The helical



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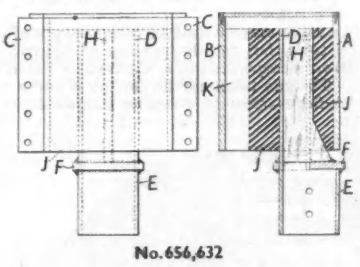
series may assume the same or opposite pitches in the associated conical members or baffle plates. The slots are cut in the metal of the cone and the metal is upset towards the outside when the cones are intended to receive gases through the inside and, on the contrary, towards the inside when the cones show their apex to the incoming flow of gas. The arrangement illustrated is designed for automobiles and is provided with four cones. The two central cones, coupled through their bases, are separated by a gap from the two other cones. For very powerful engines it is possible to associate several silencers in a single casing.—*August* 29, 1951.

CIVIL ENGINEERING

656,632. September 17, 1948.—Fenders for Jetties, Dunlop Rubber Company, Ltd., 1, Albany Street, London, N.W.1, and Geoffrey William Trobridge and Robert Maxwell Seddon, both of the company's works at Fort Dunlop, Erdington, Birmingham, 24.

This invention relates to shock absorbers for fender pile heads. Referring to the drawings, the shock absorber comprises a metal casing formed of two similar halves *A* and *B* having external flanges *C*, each half being shaped with a flat face parallel with the axial plane and an arcuate portion on each side of it. The casing is open at the lower end, while the other end is closed by a metal cover plate. Within the casing is a rigid tubular member *D*, having its upper end spaced slightly from the inner face of the cover plate and extending beyond the open end of the casing. The lower end or socket *E* of the tubular member is of annular cross section, while the cross section of the remainder is kidney



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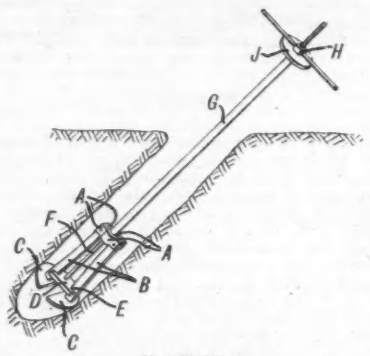
shaped. The tubular member is arranged within the half *A* of the casing with the lobes of the kidney shape directed one towards the arcuate portion on each side of the flat face of the half casing, the plane of symmetry of the member coinciding with the plane of symmetry of the casing passing through the two halves *A* and *B*. A plate *F*, pierced by a hole of shape similar to, but slightly larger than, the cross section of the kidney-shaped portion of the tubular member fits over it, and is located against the top of the socket *E*, and has a strengthening rib *H*. The tubular member *D* is positioned in the casing by a soft vulcanised rubber component *J* which fills the space between the casing and the member, except for a semi-cylindrical cavity *K* whose plane surface coincides with the flat face of that part of the casing remote from the rigid tubular member. The thickness of rubber between the tubular member and the flat face of the half casing *B* is considerably greater than the thickness of rubber between the member and the half casing *A*. The flanges *C* are drilled for bolting the two halves of the casing together and for fixing the shock

absorber to the wall of a jetty. The specification shows methods of mounting the shock absorbers described.—*August* 29, 1951.

656,663. April 28, 1949.—ANCHORING STRAINING WIRE RODS, Jack Miles Reid, Bakers Farm, Bramley, Near Basingstoke, Hampshire.

This invention concerns a means for anchoring straining or guy wire rods for use with telegraph wire supporting poles, pylons or the like. Referring to the drawing, the supporting part *A* comprises two comparatively narrow plates fixed together, and having pivoted between the ends the upper ends of two depending arms *B*, made of strip metal. These arms are curved downwardly and outwardly, and fitted at their lower ends with spade-like parts *C*, which dig into the sides of a hole. The means for splaying the arms apart comprises a plate *D* formed at each end with a rectangular recess *E* for receiving the adjacent part of



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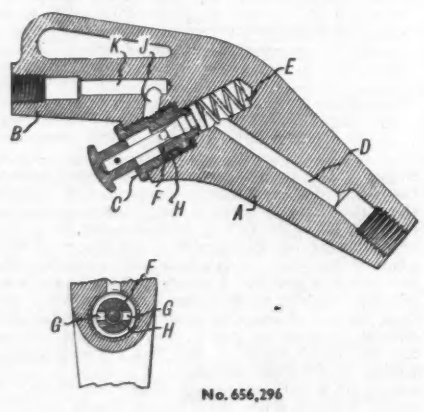
the associated arm. This plate member is adapted to be displaced vertically so that as it slides upwards, the lower ends of the arms are forced apart and dig into the ground. Conversely, when the plate is moved downwards the two arms are permitted to move towards one another so as to reduce the spacing of their lower ends. For imparting vertieal sliding movement to the plates *D* a rod *F* can slide through an aperture formed between the centre parts of the two narrow plates on which the arms are pivoted. The upper part of this rod is threaded as shown so that by locating a tube or sleeve *G* over the rod above the two narrow plates and screwing a nut *H* against the upper end of the tube the rod is displaced axially and the plate fed up or down to splay the arms or to close the arms. As shown in the drawings the sleeve has a disc or plate *J* at one end.—*August* 29, 1951.

WORKSHOP TOOLS AND APPLIANCE

656,296. July 29, 1948.—VALVE FOR PNEUMATIC TOOL, William Louis Ulmer, Cleveland Heights, Ohio, U.S.A. (*Assignee of Jack Errett Terry, of 9680, Ridge Road, North Royalton, Ohio, U.S.A.*).

The valve may be used in various types of pneumatic tools, but for the purpose of illustration it is shown incorporated in a hand-manipulated blow gun. The gun has a handle portion *A* and a nozzle *B*. A finger-operated valve mechanism *C* controls



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the flow of air through the gun. The handle is bored longitudinally to provide a high-pressure passage *D* and threaded for attaching the nipple of an air supply line. A cylindrical deep cavity *E* formed in the casting, has its outer end counterbored and threaded for receiving a tubular valve body. The drawings show the general design of the valve. The valve stem is displaced by pressing the button and it is normally urged toward the valve closing position by a coil spring interposed between the inner end of the cavity and the valve head, so that the displacement of the valve stem by the finger of the operator may be accurately controlled. Air passing through passage *F* escapes through passages *G* and into the bore *H*. A low-pressure passage *J* leads from bore *H* upward to a bore *K*, which is counterbored and threaded for the attachment of a nozzle to the gun, through which air is directed by the operator to the desired point.—*August* 22, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Sat., Sept. 22nd.—OXFORD BRANCH: Visit to Clarendon Laboratories, Oxford, and lecture on "Electrical Apparatus Used in Nuclear Research," 2.30 p.m.

Cement and Concrete Association

Mon. and Tues., Sept. 24th and 25th.—Institution of Civil Engineers, Great George Street, Westminster, S.W.1, Symposium, "Prestressed Concrete Statically Indeterminate Structures."

Engineers' Guild

Thurs., Sept. 27th.—Caxton Hall, Caxton Street, Westminster, S.W.1, Annual General Meeting, 6 p.m.

Thurs., Oct. 4th.—YORKSHIRE BRANCH: Hotel Metropole, Leeds, Annual General Meeting, speaker H. Nimmo, 7 p.m.

Illuminating Engineering Society

Thurs., Sept. 27th.—NOTTINGHAM CENTRE: Victoria Station Hotel, Nottingham, Annual Luncheon and Induction of Chairman.——BRADFORD GROUP: Yorkshire Electricity Board, 45–53, Sunbridge Road, Bradford, "Lighting of Trains and Public Service Vehicles," S. Anderson and C. Dykes Brown, 7.30 p.m.

Fri., Sept. 28th.—LEEDS CENTRE: Guildford Hotel, The Headrow, Leeds, 1, Chairman's Address, J. Sewell, 7 p.m.

Incorporated Plant Engineers

Mon., Sept. 24th.—WEST AND EAST YORKS BRANCH: The University, Leeds, "Pluto," Film and Lecture by Stewarts and Lloyds, Ltd., 7.30 p.m.

Fri., Sept. 28th.—BIRMINGHAM BRANCH: Imperial Hotel, Birmingham, Symposium of Films on "Welding," 7.30 p.m.

Institute of Marine Engineers

Tues., Oct. 2nd.—85, Minories, London, E.C.3, Presidential Address, S. F. Dorey, F.R.S., 5.30 p.m.

Institute of Navigation

Fri., Oct. 19th.—Royal Geographical Society, 1, Kensington Gore, S.W.7, Presidential Address, "Navigation and the Shipping Industry," Sir Robert Watson-Watt, 3 p.m.

Institute of Petroleum

Wed., Oct. 3rd.—26, Portland Place, London, W.1, "The Training of a Technologist," 5.30 p.m.

Institute of Road Transport Engineers

Tues., Sept. 25th.—N.E. CENTRE: Dunelm Hotel, Durham, "Garage Equipment and Service Tools," R. M. Walker, 7 p.m.

Institution of Mechanical Engineers

Sat., Sept. 22nd.—N.W. GRADUATE SECTION: Engineers' Club, Albert Square, Manchester, "High-Pressure Steam Boilers," G. Cooke, 2.30 p.m.

Wed., Sept. 26th.—SOUTHERN BRANCH: Technical College, Brighton, discussion, "Britain—Liquid Fuel—Engineers," introduced by Captain (E.) H. Moy, 7 p.m.

Thurs., Sept. 27th.—N. W. BRANCH: Engineers' Club Albert Square, Manchester, "Some Problems in the Manufacture of Experimental Gas Turbines," L. H. Leedham, 6.45 p.m.

Institution of Mining and Metallurgy

Thurs., Sept. 27th.—Geological Society, Burlington House, W.1, "Work in High Air Temperatures in a Fire in Mysore Mine, Kolar Gold Field," W. B. Roantree, 5 p.m.

Institution of Production Engineers

Mon., Oct. 1st.—WESTERN SECTION: Grand Hotel, Bristol, Formation of Graduate Section, 7.15 p.m.

Tues., Oct. 2nd.—READING SECTION: Great Western Hotel, Reading, "Industrial Incentives," R. N. Marland, 7.15 p.m.

Wed., Oct. 3rd.—NOTTINGHAM SECTION: Victoria Station Hotel, Nottingham, "The Fatigue of Metals," J. A. Pope, 7 p.m.——SOUTH ESSEX SECTION: S.E. Essex Technical College, Barking, "The Problems of Modern Management," Lewis C. Ord, 7.30 p.m.——DUNDEE SECTION: Imperial Hotel, Arbroath, "Cast Iron as an Engineering Material," H. T. Angus, 7.30 p.m.

Thurs., Oct. 4th.—LONDON SECTION: Royal Empire Society, Northumberland Avenue, W.C.2, "Increased Productivity by the Use of Compressed Air," N. P. Watts, 7 p.m.

Fri., Oct. 5th.—WEST WALES SECTION: Central Library, Alexandra Road, Swansea, "History and Development of the Tube Industry," W. Goldsworthy, 7.30 p.m.

Royal Aeronautical Society

Thurs., Oct. 4th.—Institution of Civil Engineers, Great George Street, S.W.1, Seventh British Commonwealth and Empire Lecture, "Air Transport in New Zealand and the South Pacific," Air Vice-Marshal Sir L. M. Isitt, R.N.Z.A.F., 6 p.m.

Sheffield Metallurgical Association

Tues., Oct. 2nd.—Grand Hotel, Sheffield, "World Survey of the Iron and Steel Industry," R. A. Hacking, 6.15 p.m.

Launches and Trial Trips

ANNO, cargo ship; built by Hall, Russell and Co., Ltd., for Mitchell and Rae, Ltd.; length between perpendiculars 120ft, breadth moulded 24ft, depth moulded 9ft 6in, deadweight 300 tons; two-cycle, single-acting, British Polar diesel engine. Launch, September 3rd.

POL XV, whale catcher; built by Hall, Russell and Co., Ltd., for Hvalfangerselskapet Polaris A/S, Larvik; length between perpendiculars 147ft 8in, breadth moulded 29ft 6in, depth moulded 18ft; Hall, Russell-Fredriksstad four-cylinder steam motor taking superheated steam at 220 lb per square inch from two Foster-Wheeler boilers. Trial, September 6th.

CHAKDINA, cargo motorship; built by Swan, Hunter and Wigham Richardson, Ltd., for the British India Steam Navigation Company, Ltd.; length between perpendiculars 455ft, breadth moulded 62ft 6in, depth moulded to shelter deck 40ft 9in, deadweight 9200 tons on 27ft 2½in draught; five holds, refrigerated 'tween decks, one 30-ton derrick and 20-ton derrick; Swan, Hunter-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 116 r.p.m., heavy oil fuel, two cylindrical muititubular boilers supply steam to auxiliaries. Trial, September 6th.

BUESTEN, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for Tonsbergs Rederiaktieselskats, Norway; length between perpendiculars 500ft, breadth moulded 65ft 6in, depth moulded 37ft 6in, deadweight 15,260 tons on 29ft 2½in draught; thirty cargo oil tanks, two pump rooms, four 18in by 14in by 24in steam duplex pumps, steam deck machinery; Wallsend-Doxford oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5100 b.h.p. at 105 r.p.m., two multitubular Scotch boilers. Trial, September 11th.

Contracts

THE COLONIAL OFFICE states that contracts for goods wagons and carriage stock worth more than £1,000,000 for railways in Malaya and East Africa have been placed with United Kingdom manufacturers. The 405 goods wagons are all for Malaya and contracts have been distributed among three firms, as follows: Birmingham Railway Carriage and Wagon Company, Ltd., 255 four-wheeled covered goods wagons; Cravens Railway Carriage and Wagon Company, Ltd., fifty bogie high-sided wagons; Gloucester Railway Carriage and Wagon Company, Ltd., 100 bogie covered goods wagons. Contracts for lightweight carriage stock for the East African Railways have been placed with the Metropolitan Cammell Carriage and Wagon Company, Ltd., for sixteen first-class bogie corridor-coaches for the Kenya section and ten first-class bogie corridor-coaches for the Tanganyika section. All these coaches are for day and night travel, each consisting of eight coupe compartments, sleeping two and seating three, with three lavatories.

RESEARCH DISCUSSIONS AT NOTTINGHAM.—During the coming session Nottingham University intends to hold a series of research discussions dealing with various branches of engineering technology, on which it is carrying out research. Admission to the series will be free and open to interested members of the public. The main object of the series will be to facilitate co-operation between the University and industry. Enrolment forms and syllabuses, which cover either the complete series or only a few selected lectures, may be obtained from the Registrar. The lectures and discussions will be held on Wednesday afternoons, from 2.30 p.m. to 4.30 p.m., beginning October 17th. The subjects to be covered are: The Dynamic Properties of Metals, Fatigue of Metals, Structural Analysis and the Use of Models, The Use of Analogies in Fluid Mechanics, Photo-elasticity, and The Dynamic Properties of Rubber.